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IX

TRANSPLANTATION OF BONE FOR DEFECTS OF THE HEAD AND NECK OF THE FEMUR

By CHARLES DAVISON, A.M., M.D., F.A.C.S, Chicago

Reprint from
SURGERY, GYNECOLOGY AND OBSTETRICS
August, 1919, pages 142-148

TRANSPLANTATION OF BONE FOR DEFECTS OF THE HEAD AND NECK OF THE FEMUR[1]

By CHARLES DAVISON, A.M., M.D., F.A.C.S., Chicago

AUTOPLASTIC transplantation of bone is of value in three types of defects of the head and neck of the femur, but in all cases the patient must be vigorous enough to withstand the operation, and young enough, as an economic possibility, to warrant the attending discomforts and dangers of the procedure and the expense of time and effort required for a successful issue.

I. Recent fracture of the neck of the femur without impaction may be repaired by grafting a segment of fibula across the line of fracture (Fig. 1). To obtain ideal results the repair should be performed early before the vitality of the capital fragment has been disturbed by lessening of its blood supply. Under favorable conditions the union of the fracture resembles healing of wounds by primary intention and without doubt the capital fragment retains its integrity and persists as a vital portion of the femur.

Case 1. B. A., male, postal clerk, aged 38, sustained an unimpacted fracture of the neck of the left femur on January 21, 1917 (Fig. 2). Transplantation of a segment of fibula across the line of fracture was performed as soon as the routine examination and preparation had been completed. A roentgenogram taken three months after operation shows the transplant grafted to both fragments with bony union of the fracture (Fig. 3). Three months later he returned to his occupation as mail distributor, which required standing and walking from eight to eleven hours daily. Positional photographs taken when he returned to work show that he could stand erect with both feet together on the floor in the normal voluntary position of rotation of the injured extremity (Fig. 5); in normal external rotation (Fig. 6); nearly normal abduction (Fig. 7); and with good flexion of the thigh on the pelvis (Figs. 8 and 9). He could at this time balance himself supporting his entire weight upon the toes of the injured extremity (Fig. 10).

A roentgenogram taken two years after operation shows bony union of the fracture with substantial callus, especially between the upper part of the neck and the trochanter. The articular surfaces of the head of the femur and the acetabulum are free from callus (Fig. 4). The roetgenogram of the caput femoris is clear. Its outline is sharp and distinct, indicating healthy living bone. The early grafting of the fragments to the transplant and to each other has preserved the vitality of the capital fragment without necessity of regeneration of the bone.

II. Ununited fracture of the neck of the femur with diminished vitality of the capital fragment may be repaired by transplanting a segment of fibula across the non-union (Fig. 1). Under favorable conditions the transplant grafts to the lower fragment in a manner similar to that in recent fractures. In the capital fragment the process is different. It simulates the healing of wounds by granulation. There is a stimulation of osteogenesis by the transplant with projection of new bone cells into the devitalized fragment which acts only as a frame-work for the deposition of new bone. The old bone is gradually absorbed as it is replaced by new bone. Under the stimulus of the transplant, new bone is deposited in and around the area of the non-

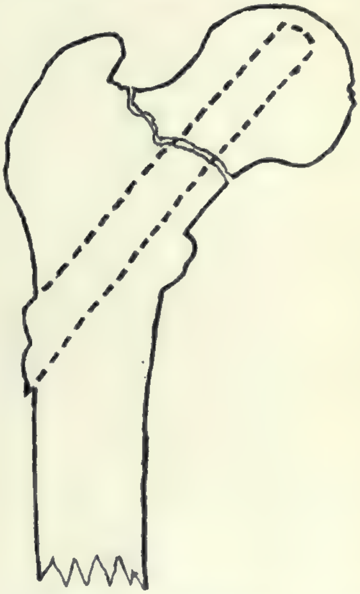

Fig. 1. Diagram of transplantation of segment of fibula across a fracture of the neck of the femur at an angle of 135° with the shaft of the femur.

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[1] Read before the Chicago Surgical Society, April 4, 1919. (For discussion see p. 217.)

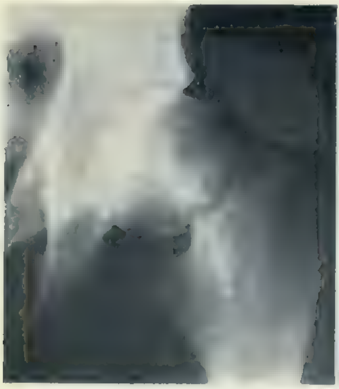


Fig. 2

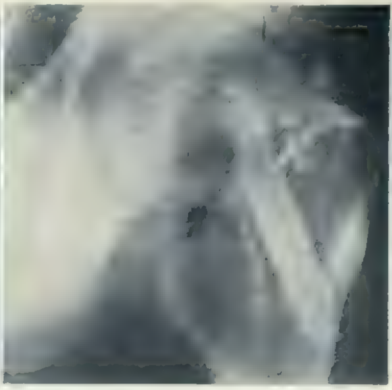


Fig. 3

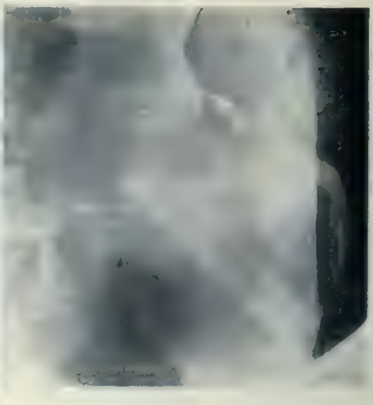


Fig. 4

Fig. 2. Case 1. Roentgenogram of recent fracture of the neck of left femur.

Fig. 3. Case 1. Roentgenogram of autoplastic repair of recent fracture of neck of femur three months after operation, showing the transplant grafted into position with osseous union of the fracture.

Fig. 4. Case 1. Roentgenogram, two years after operation, showing bony union of the fracture with substantial callus between the upper part of the neck and the trochanter.

union, until the old fracture is obliterated. Later both the transplant and the new bone are absorbed and modified until there is compensation between elasticity, strength, and function.

Case 2. F. M. male, lather, aged 36, presented himself with an ununited fracture of the neck of

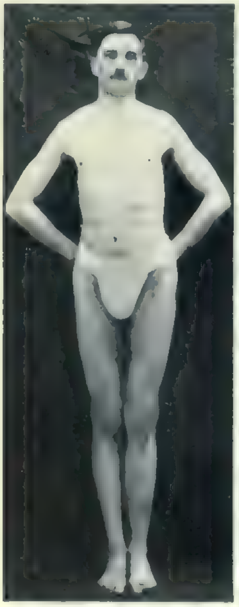


Fig. 5

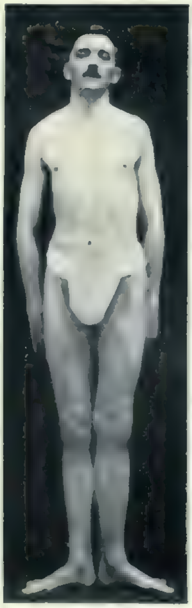


Fig. 6

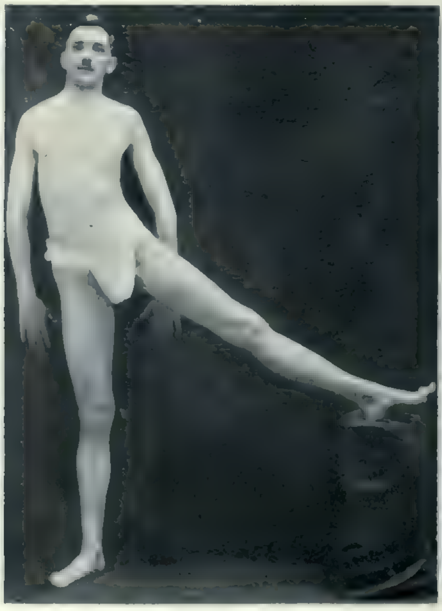


Fig. 7

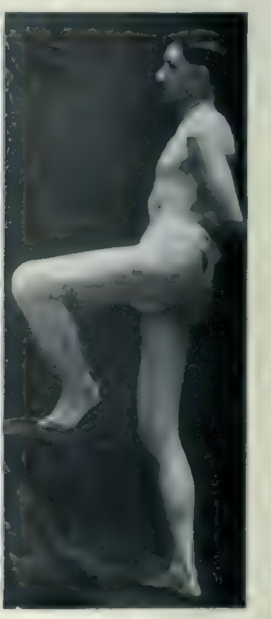


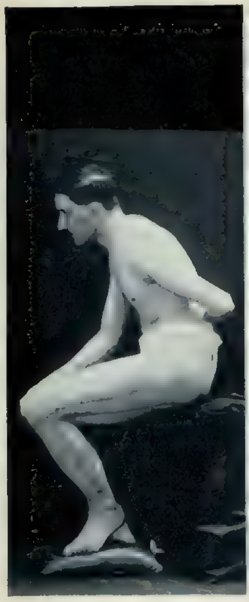
Fig. 8

Fig. 5. Case 1. Photograph, six months after operation, showing both feet of the patient together in normal rotation.

Fig. 6. Case 1. Photograph, six months after operation, showing normal external rotation of the injured extremity.

Fig. 7. Case 1. Photograph, six months after operation, showing nearly normal abduction of the injured extremity.

Fig. 8. Case 1. Photograph, six months after operation, showing the amount of flexion of the thigh upon the pelvis.



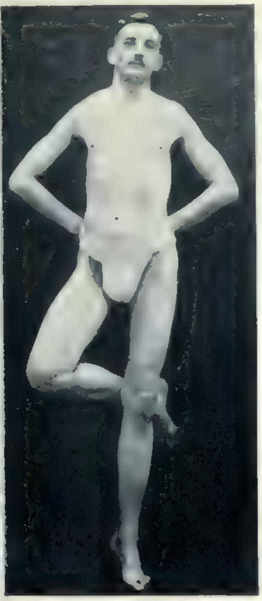


Fig. 9. Case 1. Photograph six months after operation, showing the amount of flexion of the thigh upon the pelvis.

Fig. 10. Case 1. Photograph, six months after operation, showing patient supporting his entire weight upon the toes of the injured extremity.

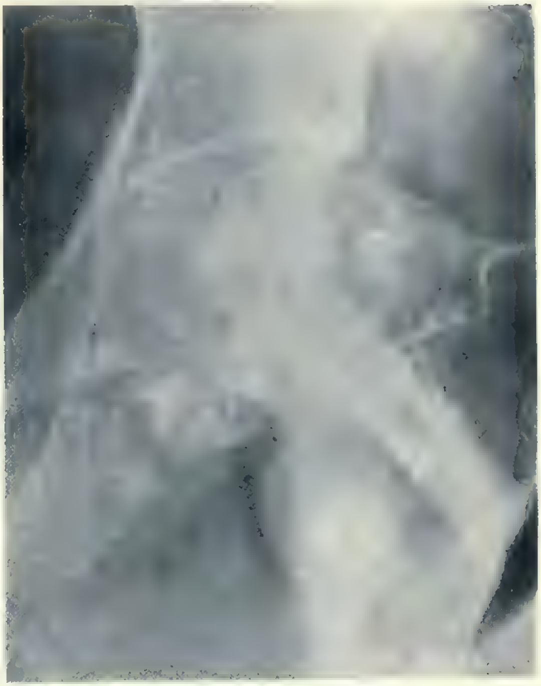


Fig. 14. Case 2. Roentgenogram, four years after operation, showing an apparently complete replacement of the capital fragment by new bone, with advanced absorption of that part of the transplant, which was within the small fragment.

the left femur of eighteen months' duration. He was suffering severe pain and was unable to walk without crutches. He had received industrial insurance for a permanent disability. A roentgenogram revealed an ununited fracture of the neck of the left femur. The upper fragment was mottled and

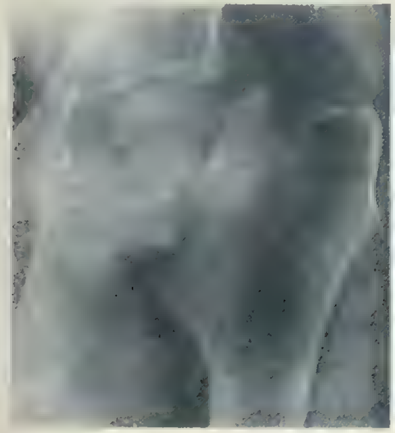


Fig. 11

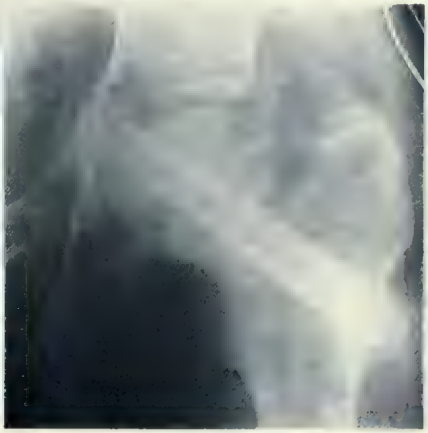


Fig. 12

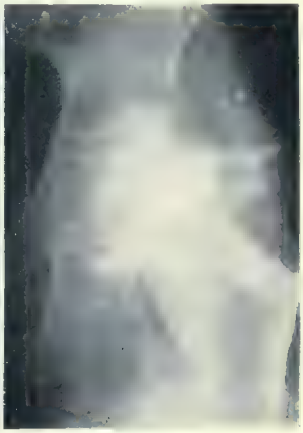


Fig. 13

Fig. 11. Case 2. Roentgenogram of ununited fracture of the neck of left femur eighteen months after injury. Capital fragment undergoing degeneration.

Fig. 12. Case 2. Roentgenogram, six months after operation, showing bony union of the pseudarthrosis.

Fig. 13. Case 2. Roentgenogram, two years after operation, showing bony union of the old fracture and partial replacement of the capital fragment by new bone, the old bone apparently acting as a limiting frame-work, shaping the outlines of the new bone.

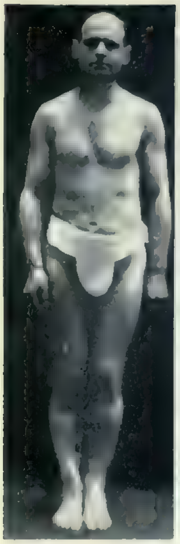


Fig. 15

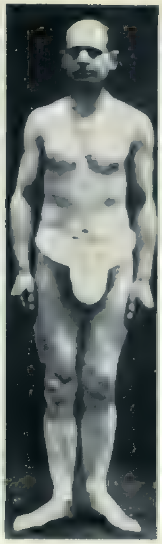


Fig. 16

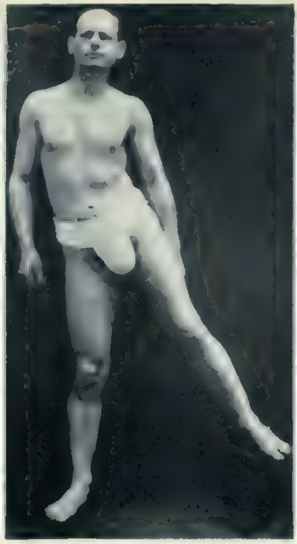


Fig. 17

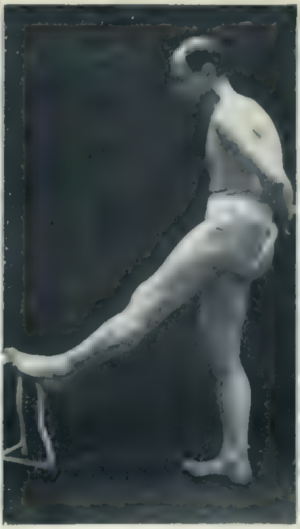


Fig. 18

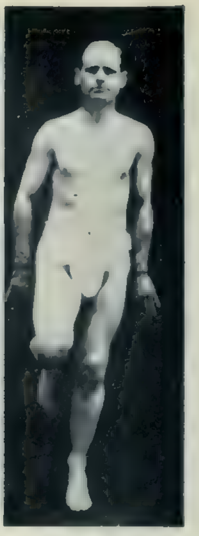


Fig. 19

Fig. 15. Case 2. Photograph, four years after operation, showing both feet together in normal rotation.

Fig. 16. Case 2. Photograph, four years after operation, showing external rotation of the injured extremity.

Fig. 17. Case 2. Photograph, four years after operation, showing abduction of the injured extremity.

Fig. 18. Case 2. Photograph, four years after operation, showing flexion of the thigh on the pelvis.

Fig. 19. Case 2. Photograph, four years after operation, showing patient supporting his entire weight upon the toes of the injured extremity.

the outline was uneven. It appeared to be undergoing degeneration (Fig. 11).

Transplantation of a segment of fibula across the pseudarthrosis was performed on January 15, 1915. After sixteen weeks of immobilization there was no motion either in the hip-joint or the pseudarthrosis.

A roentgenogram taken six months after operation shows that the transplant had been driven through the soft capital fragment into the acetabulum. It shows bony union of the pseudarthrosis, also between the transplant and shaft of the femur, and between the transplant and the pelvis (Fig. 12).

Vigorous efforts made to mobilize the hip-joint were so successful that he returned to his work as a lather, two years after operation, earning full wages.

A roentgenogram taken two years after operation shows absorption of the upper end of the transplant so that the hip-joint motion was possible. It shows the deposition of a strong mass of callus connecting the trochanter to the capital fragment above the transplant. It shows the replacement of the capital fragment by new bone, the old bone apparently acting as a limiting frame-work, shaping the outlines of the new bone. This is particularly apparent at the lower part of the capital fragment, where in the original roentgenogram (Fig. 11), there was shown beginning disintegration of the surface of that fragment. This roentgenogram shows new bone breaking through at that point and forming an irregular nodule (Fig. 13).

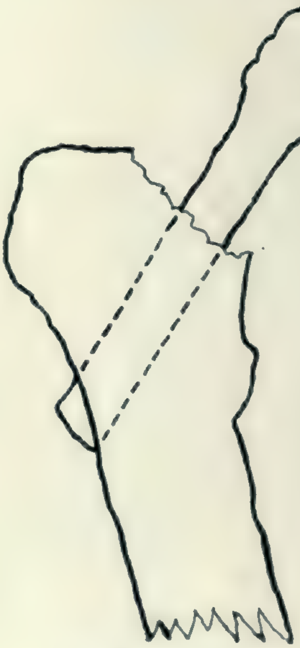
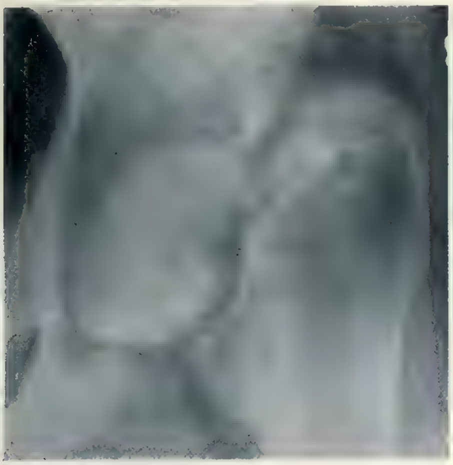


Fig. 20. Diagram illustrating method of transplantation of the upper part of fibula into the upper end of shaft of femur to remedy loss of head and neck of femur.



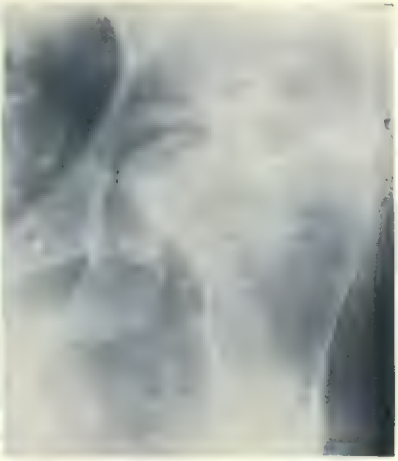


Fig. 21 (at left). Case 3. Roentgenogram of old fracture of neck of left femur, two years after injury, showing necrosis of the capital fragment.

Fig. 22. Case 3. Roentgenogram, one year after operation, showing the transplant grafted to the femur with the head of the fibula in the acetabulum.

A roentgenogram taken four years after operation shows an apparently complete replacement of the capital fragment by new bone with advanced absorption of that part of the transplant within the small fragment (Fig. 14).

The amount of re-establishment of function is

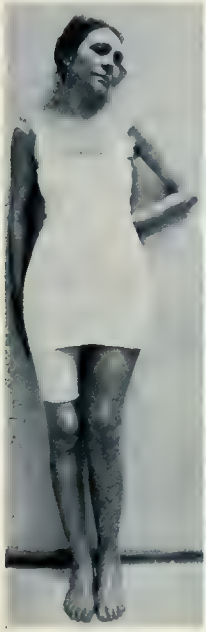


Fig. 23

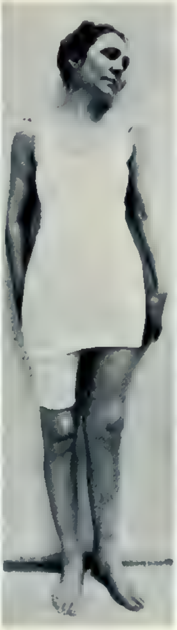


Fig. 24

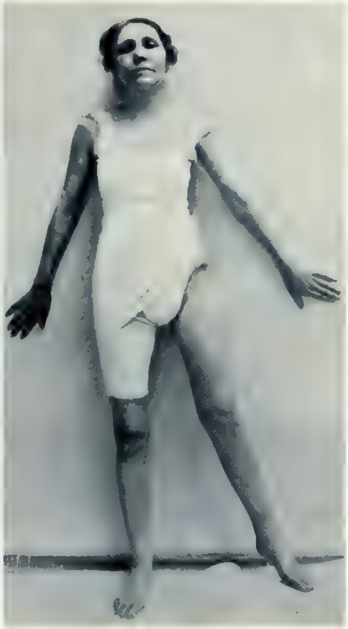


Fig. 25

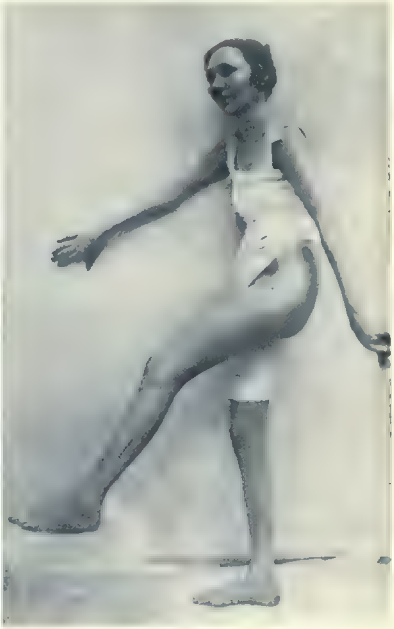


Fig. 26

Fig. 23. Case 3. Photograph, one year after operation, showing normal voluntary position of rotation of the injured extremity.

Fig. 24. Case 3. Photograph, one year after operation, showing amount of voluntary external rotation of the injured extremity.

Fig. 25. Case 3. Photograph, one year after operation, showing the amount of abduction.

Fig. 26. Case 3. Photograph, one year after operation, showing amount of flexion of the thigh upon the pelvis.

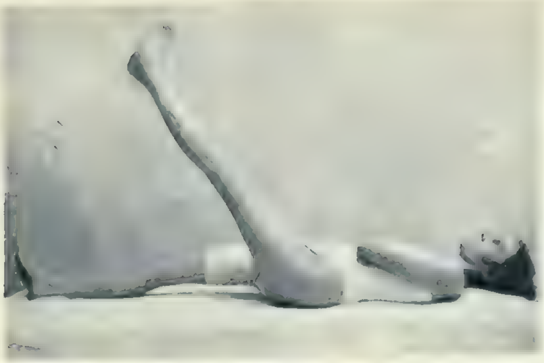


Fig. 27. Case 3. Photograph, one year after operation, showing amount of flexion of the thigh upon the pelvis.

illustrated by positional photographs taken four years after operation. He can stand erect with both feet together on the floor in the normal voluntary position of rotation of the injured extremity (Fig. 15) and in normal external rotation (Fig. 16). He has fair abduction (Fig. 17) and fair flexion of the thigh on the pelvis (Fig. 18). He can balance himself on the toes of the injured extremity (Fig. 19). He is now working as a stock-man in a wholesale sponge house, earning a respectable living and supporting a family.

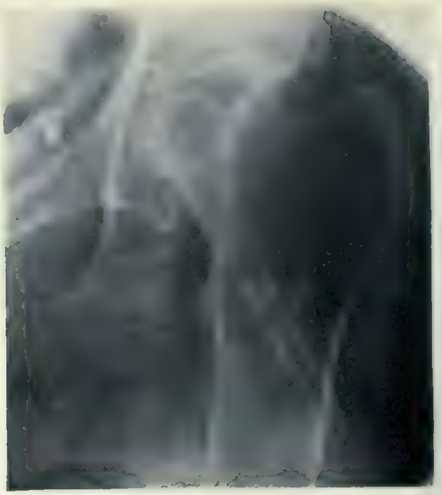


Fig. 28. Case 3. Roentgenogram, two years after operation, showing hypertrophy of that part of the transplant between the femur and the acetabulum.

III. The head of the femur, destroyed by injury or disease, may be replaced and fair function re-established by transplantation of the head and upper part of the fibula into the upper end of the shaft of the femur in such a manner that the articular surface of the head of the fibula will articulate with

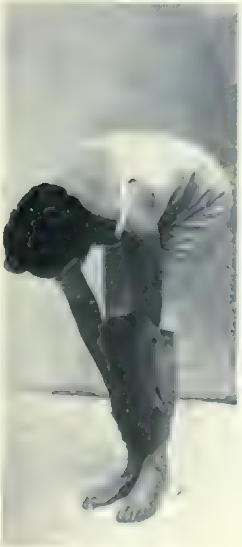


Fig. 29

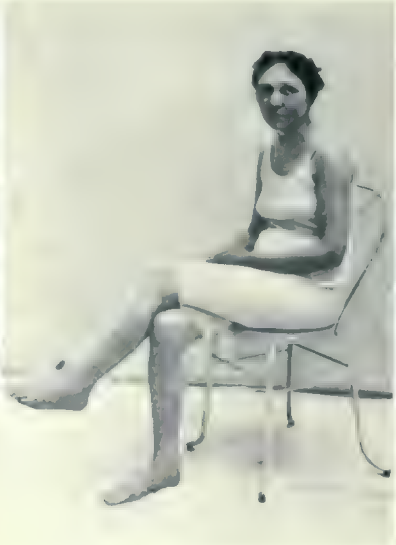


Fig. 30

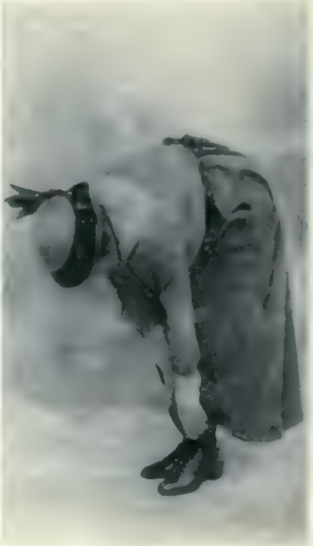


Fig. 31

Fig. 29. Case 3. Photograph, two years after operation, showing flexion of the thigh upon the pelvis.

Fig. 30. Case 3. Photograph, one year after operation, showing combined flexion and adduction.

Fig. 31. Case 3. Photograph, two years after operation, showing the patient tying shoe-lace on the injured extremity.

the acetabulum (Fig. 20). Under favorable conditions the transplant will graft to the shaft of the femur. The part of the transplant which replaces the head and neck of the femur, will hypertrophy until its size and strength are sufficient to meet the functional demands made upon the hip-joint in walking.

Case 3. C. K., female, aged 50, presented herself with the history of an injury to the hip two years previously. She was complaining of great pain and was walking with the aid of crutches.

A roentgenogram taken at this time revealed an old fracture of the neck of the femur, with necrosis of the capital fragment (Fig. 21). Transplantation of the upper end of the fibula into the upper end of the femur was performed on April 15, 1916. Immobilization by a body plaster-of-Paris cast was maintained for seven months. This was followed by vigorous passive exercise, continued until walking was permitted. A roentgenogram taken one year after operation shows the transplant grafted to the femur with the head (fibula) of the transplant in good position in the acetabulum (Fig. 22).

One year after operation the patient could stand erect with both feet together on the floor in the normal voluntary position of rotation of the injured extremity (Fig. 23) and with a fair degree of voluntary external rotation (Fig. 24). She had a fair degree of abduction (Fig. 25) and nearly one-half of the normal voluntary flexion of the thigh upon the pelvis (Figs. 26 and 27). She was not permitted to walk without support for two years after operation.

A roentgenogram taken two years after operation shows the transplant in position in the acetabulum; that the part of the transplant within the shaft of the femur has persisted without either absorption or hypertrophy; that the part of the transplant between the femur and the acetabulum has markedly increased in size; that a strong brace of new bone has been deposited in the angle between the upper end of the femur and the transplant (Fig. 28).

Two years after operation she could walk; she could go up and down stairs; she could flex the thigh sufficiently to cross the normal thigh while sitting (Fig. 29); she could tie the shoe-laces on the foot of the injured extremity while standing (Fig. 31).

Spiral Fractures of the Tibia

BY

CHARLES DAVISON, M.D.
CHICAGO

FROM THE
AMERICAN JOURNAL OF THE MEDICAL SCIENCES
March, 1918, No. 3, vol. clv, p. 323

Extracted from the American Journal of the Medical Sciences,
March, 1918, No. 3, vol. clv, p. 323.

SPIRAL FRACTURES OF THE TIBIA.

By

Charles Davison, M.D.,
CHICAGO.

Spiral fractures of the tibia are produced by torsion and bending of the leg, and are always accompanied by fractures of the fibula. Spiral fractures are more common in the tibia than in any other bone, constituting fully one-seventh of all fractures of the shaft of the tibia. Adult males are more subject to this injury, probably because of their more hazardous occupations.

The mechanism of these injuries shows that they are the result of indirect violence. A man missteps with one foot or slips on the ice or a banana peel, the other foot remaining fixed in contact with the ground. As his body turns and he struggles to regain his equilibrium, his whole weight is thrown upon one leg. The rotation of the body upon the leg with the foot fixed furnishes a torsion force of the type which produces spiral fractures of the tibia.

In whatever manner the leg may be subjected to a twisting and bending force of sufficient intensity, the tibia, which is the substantial weight-bearing bone of the leg, breaks at the location of least resistance and greatest strain. These fractures uniformly occur at the region of the junction of the middle and lower thirds of the tibia. This is the place of least resistance and greatest torsion strain, because of the size, shape and character of that part of the bone. At this location the bone is smaller and more nearly cylindrical than elsewhere, and the compact bone is extremely dense and inelastic.

The spiral fracture in the tibia is accompanied by a fracture of the fibula, usually impacted in rotation. The fibula is broken in its upper part in the line corresponding to the torsion force. If the direction of the spiral of the fracture in the tibia is followed upward a characteristic injury will be found in the fibula. This injury will be at a very definite location in the fibula, depending upon the angle of the axis of the spiral in the fracture of the tibia to the shaft of the tibia. The axis of the spiral extended until it reaches the fibula, locates the break in the fibula.

The mechanism of the fracture in the fibula is that of indirect violence. When the tibia breaks the weight of the body and the torsion force are transferred to the fibula, and that bone breaks at a higher level, depending upon the length and direction of the spiral in the tibial fracture. The fragments of the fibula are nearly always impacted. The lower fragment is rotated to correspond to the rotation displacement of the lower fragment of the tibia. This impaction is important, as when it persists it prevents reduction of the fracture in the tibia.

The deformity produced by spiral fracture of the tibia, with impacted fracture of the fibula, as shown by the roentgenogram, is characteristic. The spiral of the fracture in the tibia curves from above downward, forward and outward. The impacted fracture in the fibula is high up, in line with the spiral of the tibial fracture, and the lower fragment is in external rotation. There is 1 cm. to 3 cm. overriding of the tibial fragments, depending upon the amount of impaction of the fibular fragments. The lower fragments of the tibia and fibula retain their normal relationship to each other. The fragments of the tibia have little contact. The amount of separation depends upon the amount of rotation in the impaction of the fragments of the fibula (Fig. 13).

Reduction of spiral fractures of the tibia by external manipulation and extension is not possible while the impaction of the fragments of the fibula remains. Even when the fragments of the fibula are liberated from impaction it is usually impossible to reduce the fracture in the tibia because of the entanglement of the upper end of the lower fragment of the fibula.

Treatment by external manipulation and external immobilization results in good union of the fibula in the impacted position, but in the majority of cases in only partial union, weak union or non-union of the tibia—the strong weight-bearing bone of the leg—in the position of the original deformity. The amount of osseous union often consists in only a slight bony bridge between the displaced fragments. Even a large amount of callus may fail to connect and fix the ends of the fragments (Figs. 1, 2 and 3).

Open operation with surgical fracture of the fibula at the same level as the fracture in the tibia is usually necessary to mobilize the lower fragment of the tibia before reduction can be accomplished. When reduction has been satisfactorily accomplished the fragments of the tibia can rarely be immobilized so that they will remain in position except by the aid of internal fixation, because of the spiral shape of the fractured surfaces.

Internal fixation in these fractures may be best accomplished by the transplantation of bone, by the grafting across the line of fracture, in the medullary canal, of a splint of fresh live bone from the same individual. This furnishes a method of alignment and fixation by a living, germ-resisting, osteogenic structure, which is treated kindly by the tissues and which heals in as an integral part of the body.

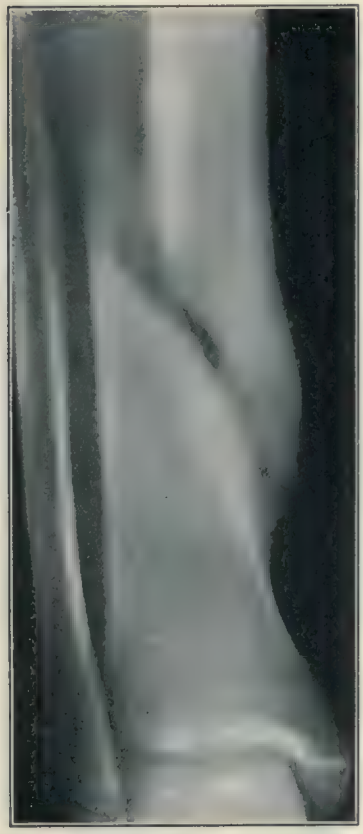


FIG. 1.—Roentgenogram of a spiral fracture of the tibia, with an impacted fracture of the fibula, treated by external manipulation and external immobilization, showing non-union of the fracture in the tibia one year after injury.

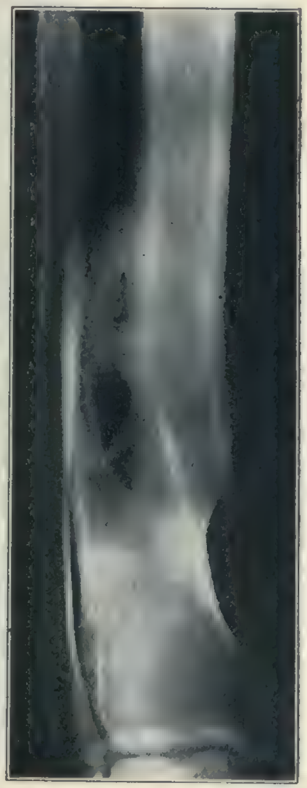
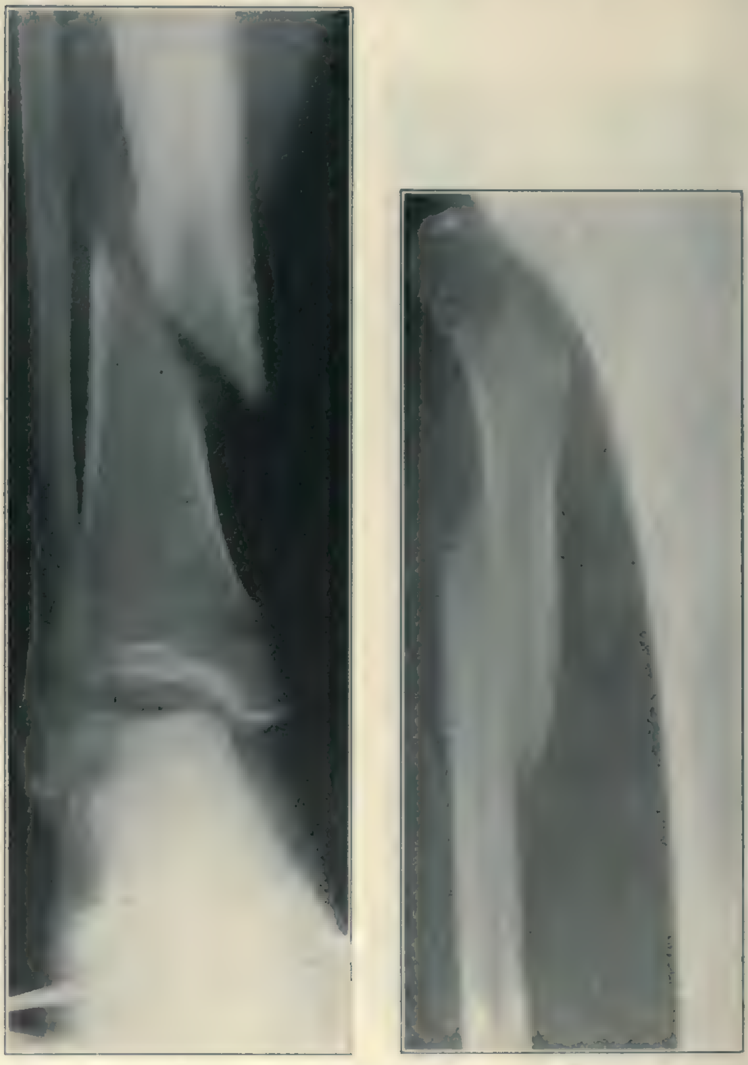


FIG. 2.—Roentgenogram of a spiral fracture of the tibia, with an impacted fracture of the fibula, treated by external manipulation and external immobilization, showing a large amount of callus, but failure of weight-bearing union.

The transplant aligns the fragments, stimulates osteogenesis at the injury, lives and grafts to the compact bone of each fragment, when actual contact has occurred between the transplant, from which the periosteum has been removed, and the compact bone of each fragment and when the limb has been properly immobilized by external means, so that there can be no movement between the transplant and its host.

Under these favorable conditions the transplant becomes a living integral portion of the repaired bone, taking its part in the functional support of the extremity and maintaining for the time its shape and size, later to be modified, like any other part of the skeleton, by the conditions and functional demands put upon it. It remains as long



a *b*

FIG. 3.—*a*, roentgenogram of spiral fracture of the tibia treated by externa manipulation, followed by nail-extension with twenty pounds of weight for three weeks, without change of position of the fragments; *b*, roentgenogram of impacted, rotated fracture of the fibula which prevented reduction.

as its support is required, and then the superfluous part is gradually absorbed as the repaired bone resumes its function. The medullary canal is reëstablished as absorption of the transplant progresses. The primary function of the transplant is the alignment of the fragments. Grafting of the transplant to the fragments is secondary, but very desirable.

The operative technic demands the rigorous application of the rules of asepsis as distinguished from antisepsis. Iodin preparation is prohibited. Antiseptics destroy the living bone cell of the transplant as quickly and surely as they destroy the pyogenic germ.

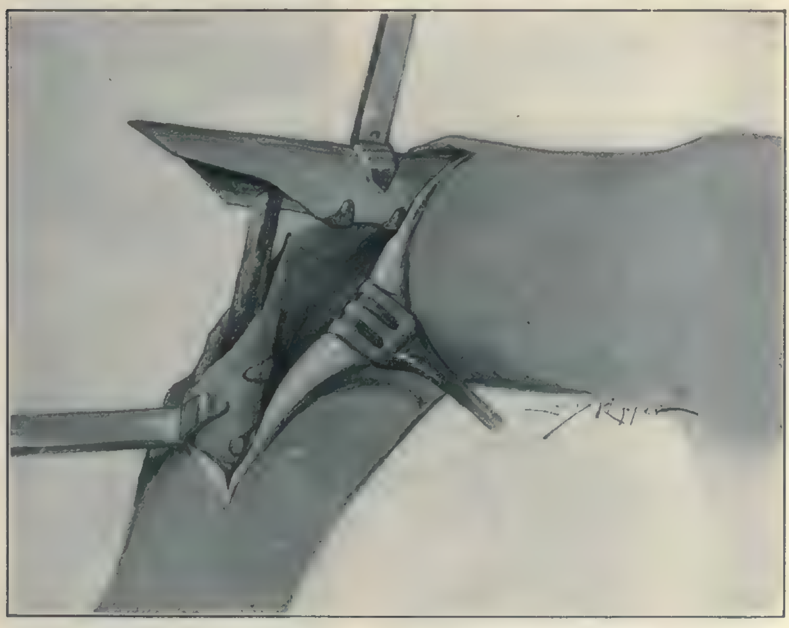


Fig. 4.—Introduction of the transplant in autoplastic repair of spiral fracture of the tibia.

The fracture in the tibia is exposed by a flap incision, so that the repaired fracture will not be directly exposed to the danger of a skin wound. The fibula is fractured with a chisel at about the same level. The fragments of the tibia are secured by small Lowman clamps for manipulation, and are elevated. The detritus produced by the injury is cleared from the wound and the fragments are prepared for the transplant. The medullary canal of each fragment is cleared, with a bone curette, of that part of the marrow which has been disturbed by the traumatism, hemorrhage or inflammation, and then examined and measured with calipers to determine the shape and size of the transplant needed to mortise the fragments together.

A transplant is usually secured from the upper part of the crest of the same tibia. In length the transplant should be sufficient to extend into each fragment at least 2.5 cm. It is fitted to the irregularities of the upper fragment so that it will slip in and out. The other end of the transplant is fitted and driven into the lower fragment. If the transplant is too large it will split the fragment and the fixation will be destroyed. Care is exercised to make the irregular fitting between the transplant and each fragment correspond, so that when the transplant is in final position the fragments will be locked by it in correct rotation. If it is doweled or the medullary canal is reamed until it is circular the spiral fragments of the tibia will rotate and the accuracy of the reduction will be lost. The end of the transplant projecting from the lower fragment is manipulated into the prepared upper fragment and the leg is straightened (Fig. 4). The muscles of the leg immediately contract and bring the fragments firmly together in alignment over the transplant. One Lowman clamp is now removed and the other is slipped over the repair so as to grasp the ends of both fragments (Fig. 5). The leg is elevated by means of the clamp and a narrow, sterile, moulded plaster splint, previously prepared and dried, is applied to the posterior part of the leg with sterile bandages above and below the wound. The clamp is removed. The wound is closed in layers by catgut sutures and dressed. A circular plaster-of-Paris cast is applied over all. The immobilization is not disturbed during the convalescence.

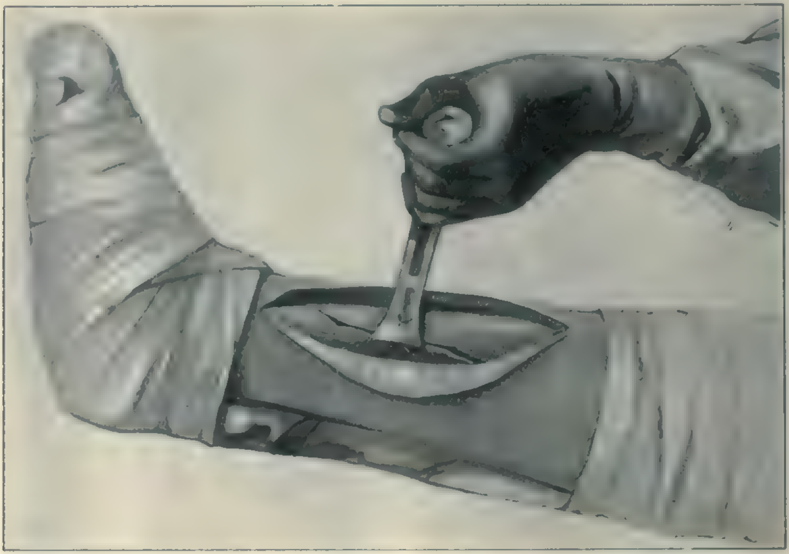


FIG. 5.—Immobilization of the fragments over the transplant, before closure of the wound and application of the cast, in spiral fracture of the tibia.

Case I.—*Spiral fracture of the tibia and impacted fracture of the fibula.*

M. W., aged forty-four years, Swedish, teamster, was admitted to Cook County Hospital March 13, 1916, suffering with a broken left leg, produced by slipping and falling on the sidewalk the previous day.

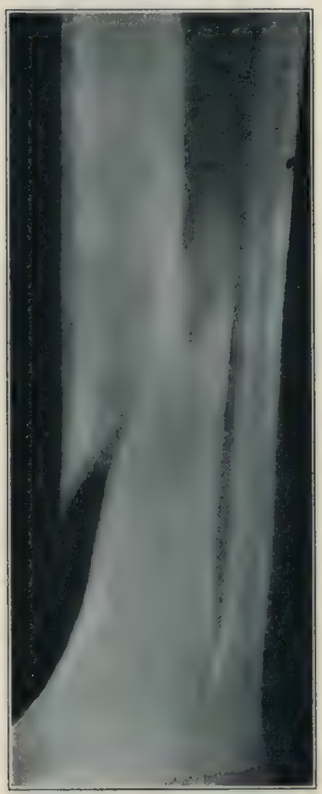


Fig. 6.—Case I. Roentgenogram of spiral fracture of the tibia.

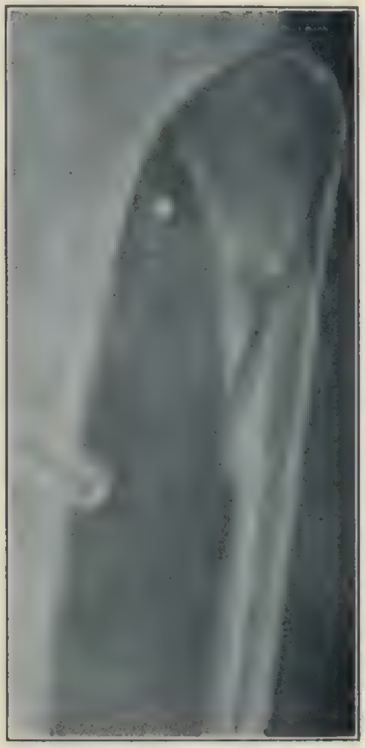


Fig. 7.—Case I. Roentgenogram of impacted, rotated fracture of the fibula, preventing reduction of the fracture in the tibia.

Roentgenograms revealed a spiral fracture of the tibia, with displacement and overriding of 2.5 cm. (Fig. 6) and an impacted, rotated fracture of the upper end of the fibula (Fig. 7).

Failing to effect reduction by external manipulation, open operation for autoplastic repair was performed March 20, 1916. The fracture was exposed by a flap incision. It was impossible to replace the lower fragment of the tibia because of the position of the impaction of the fragments of the fibula. To facilitate reduction of the fragments of the tibia the fibula was broken at the same level.

A transplant 15 cm. in length was obtained from the crest of the same tibia well above the fracture. The thickness of the transplant was determined by caliper measurements of the medullary canal of the fragments and the defect between them. After careful fitting the transplant was driven into the medullary canal of the lower fragment. The free end of the transplant was then manipulated into the medullary canal of the upper fragment. The fragments were placed in accurate reduction, with a clamp holding them in position during subsequent manipulations. A sterile, posterior, moulded splint was bandaged to the leg above and below the wound for

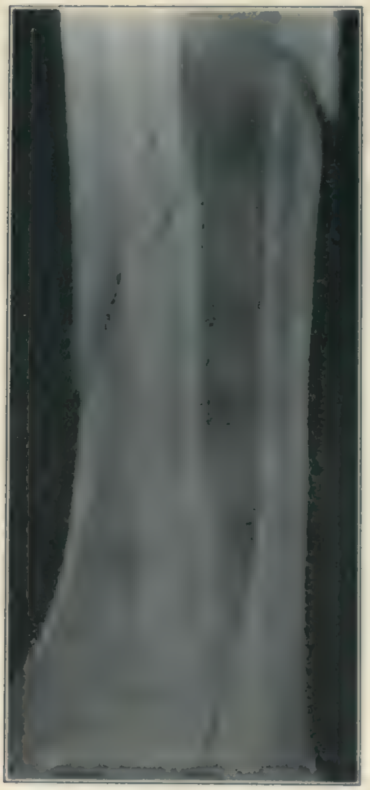


Fig. 8. — Case I. Roentgenogram of autoplastic repair of spiral fracture of the tibia, immediately after operation, showing the transplant across the line of fracture, securing the fragments in reduction.

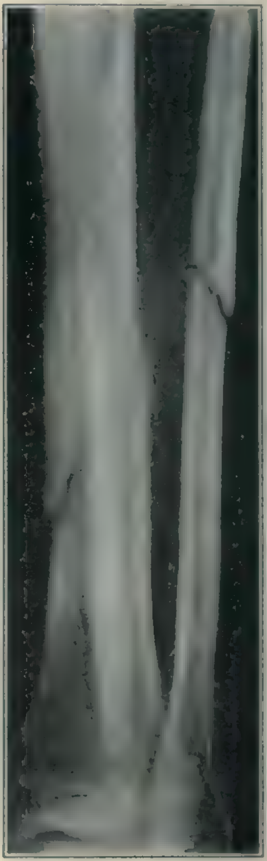


Fig. 9.—Case I. Roentgenogram of autoplastic repair of spiral fracture of the tibia, eight weeks after operation, showing the transplant grafted into the medullary canal and bony union of the fracture.

temporary support. The clamp was removed, the wound closed, dressed with gauze and a circular cast applied over all.

A roentgenogram taken after the operation revealed the transplant in the medullary canal across the line of fracture of the tibia, supporting the fragments in anatomical reduction (Fig. 8).

The immobilization was not disturbed for four weeks, when healing appeared to be complete and union of the fracture was firm. A roentgenogram taken eight weeks after operation revealed good union of both bones (Fig. 9). Functional recovery was apparently complete.

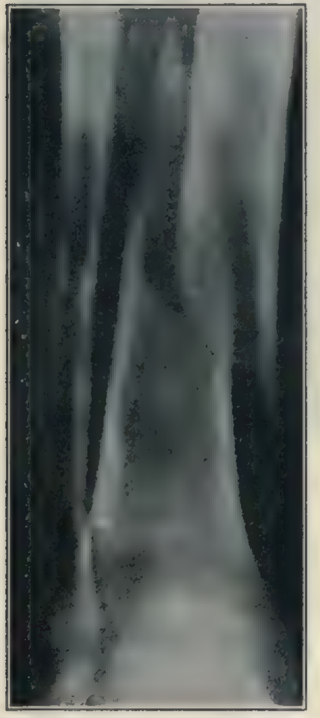


FIG. 10.—Case II. Roentgenogram of compound spiral fracture of the tibia.

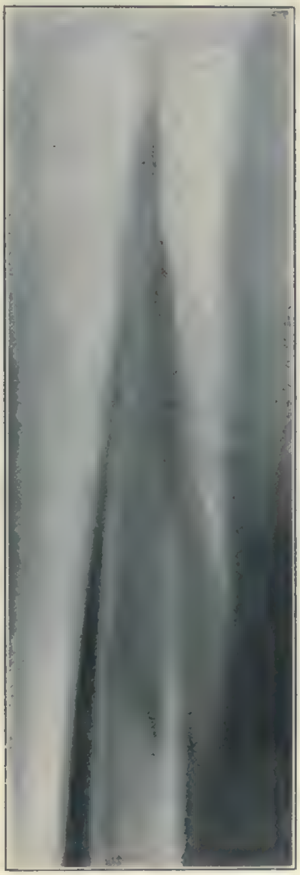


FIG. 11.—Case II. Roentgenogram of rotated spiral fracture of the fibula.

CASE II.—*Compound spiral fracture of the tibia and impacted fracture of the fibula.*

J. W., aged forty years, American, bench worker, was admitted to Cook County Hospital on May 11, 1916, with a compound fracture of the right leg. He gave a history of having been thrown while scuffling. His toe was caught under the edge of a carpet and his leg twisted as he fell.

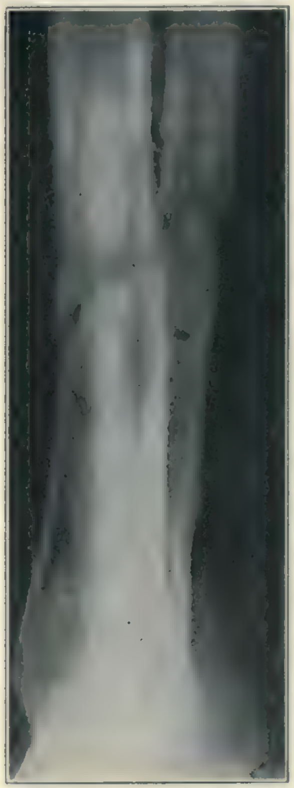


Fig. 12.—Case II. Roentgenogram of autoplastic repair of spiral fracture of the tibia, five weeks after operation, showing the transplant grafted into the medullary canal across the line of fracture and bony union of the fracture.

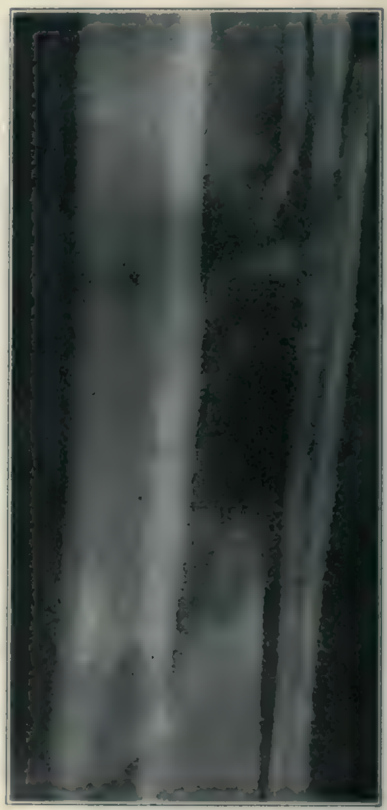


Fig. 13.—Case III. Roentgenogram of a spiral fracture of the tibia and an impacted fracture of the fibula.

Examination showed a fracture of the tibia, with an external wound communicating with the fracture. Roentgenograms revealed a long spiral fracture of the lower third of the tibia (Fig. 10), accompanied by a rotated, impacted fracture of the fibula immediately below its head (Fig. 11). The lower fragment of the tibia was rotated and displaced outward. There were 2.5 cm. overriding of the fragments.

The wound was cleansed and dressed and the extremity was immobilized in a fracture-box. Sterile healing of the wound of the soft parts was complete in three weeks.

The position of the fragments not having been changed by treatment, open operation for reduction and fixation of the fracture by the same technic as in Case I was performed May 31, 1916.

When the cast was removed at the end of five weeks, good union of the fracture was present (Fig. 12).

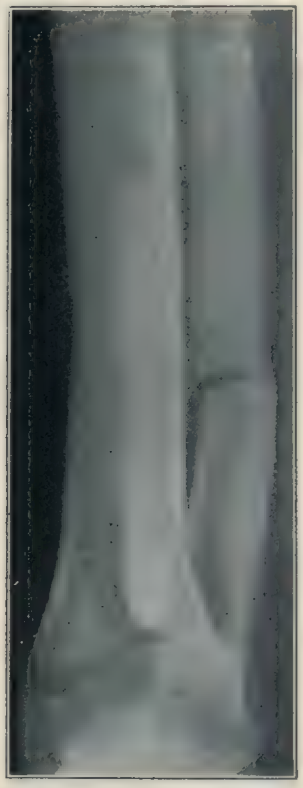


Fig. 14.—Case III. Roentgenogram of autoplastic repair of spiral fracture of the tibia, two months after operation, showing the transplant grafted across the line of fracture and bony union of the fracture.

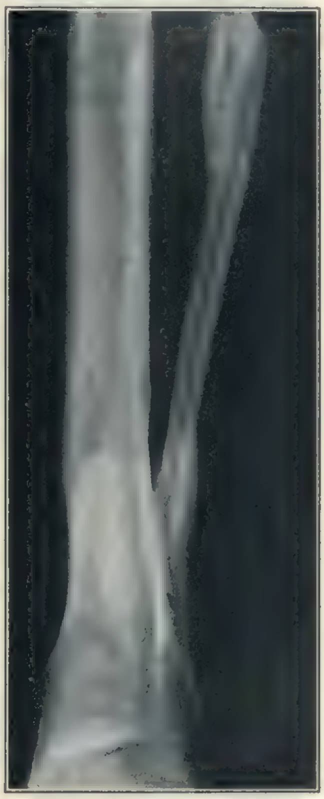


Fig. 15.—Case III. Roentgenogram of autoplastic repair of spiral fracture of the tibia, eighteen months after operation.

Case III.—*Spiral fracture of the tibia and impacted fracture of the fibula.*

L. K., aged thirty-three years, American, laborer, was admitted to Cook County Hospital January 10, 1914, with a fracture of the left leg. A roentgenogram showed a spiral fracture of the tibia and an impacted fracture of the fibula. There was overriding and complete displacement of the fragments of the tibia (Fig. 13).

After repeated failures of reduction by external manipulation and traction, open operation for autoplastic repair was performed two weeks after injury. The technic of the operation was similar to that used in Case I.

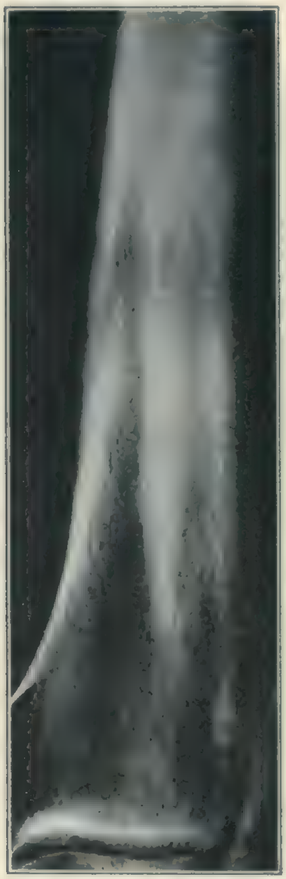


FIG. 16.—Case III. Roentgenogram of autoplastic repair of spiral fracture of the tibia, eighteen months after operation, showing absorption of the greater part of the transplant and reëstablishment of the medullary canal.

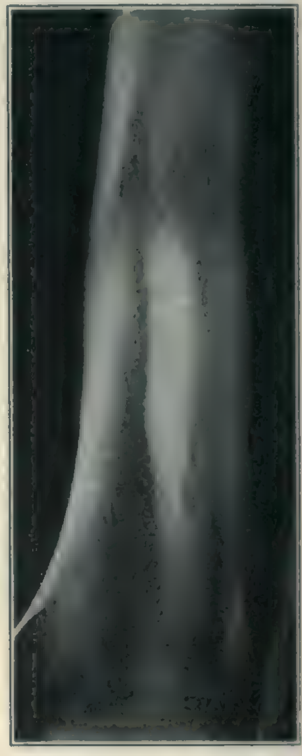


FIG. 17.—Case III. Roentgenogram of the same area shown in Fig. 16, thirty months after operation, showing practically no further absorption of the transplant.

Firm union appeared to be present when the cast was removed four weeks after operation. A roentgenogram taken eight weeks after operation shows anatomical reduction of the fragments of the tibia and bony union of the fracture (Fig. 14). A roentgenogram taken eighteen months after operation shows complete bony repair of all fractures, but with much less callus surrounding the fractures of the tibia than those of the fibula (Fig. 15). It also shows partial absorption of the transplant. The medullary canal has been reëstablished, and apparently only that part of the transplant remains which is needed for the functional support of the tibia (Fig. 16).

A roentgenogram of the tibia taken thirty months after operation shows the condition of the transplant to be almost identical with the examination of the previous year. The absorption of the transplant has apparently ceased. What remains seems to have become a permanent support to the tibia at the point of the healed fracture, correlating the strength of the bone with its functional necessities (Fig. 17).

Conclusions. 1. Treatment of spiral fractures of the tibia by external reduction and external immobilization usually results in imperfect union of the fragments with defective function of the leg.

2. Treatment by open operation and autoplastic repair usually results in early good anatomical union of the fragments with restoration of the strength and function of the leg.

3. The autoplastic transplantation of bone in the repair of a recent spiral fracture of the tibia is a capital operation, which requires careful technic, capable assistants and aseptic surroundings.

10

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PROSTATECTOMY COMBINING THE ADVANTAGES OF THE SUPRAPUBIC AND PERINEAL METHODS USUALLY EMPLOYED[1]

By A. J. OCHSNER, M.D., LL.D., F.A.C.S., Chicago
Surgeon in Chief, Augustana and St. Mary's Hospitals

THE following method of performing prostatectomy has proved so satisfactory in my hands that it seems worth while to suggest that others give the operation a trial. Before adopting this method, I made use of the suprapubic method which was popularized by Freyer, of London, and the perineal method employed with such marked success by Young, of Baltimore.

Both methods are satisfactory. The former is simpler and can be executed in less time, exposing the patient to a shorter period of anæsthesia. This, however, is of much less importance since we employ spinal anæsthesia in all cases in which the patient is very old or in which there exist other reasons contra-indicating the use of ether anæsthesia. In a large proportion of these cases, however, the drainage of the bladder is not satisfactory and the period of healing of the suprapubic wound is long and exceedingly disagreeable to the patient.

The perineal operation, on the other hand, is much more difficult except in the hands of experts with a large experience, and even in such hands the average time consumed is about four times as great in this operation as it is when the Freyer method is used.

The drainage is satisfactory and in expert hands the results are about equal.

In these patients who are generally old and not good surgical risks, it seems important, if possible, to combine the good qualities of these two operations in a method which will embody the advantages of both methods and avoid their disadvantages.

The reason that it is possible to execute the Freyer method with such ease and facility lies in the fact that, after the bladder has been opened through a suprapubic incision, the finger can be carried into the urethra and the mucous membrane cut or torn. The end of the finger then rests between the gland and its capsule and the finger can be swept around the gland so that in a few moments it is entirely free. This is true except that in some instances there are a few adhesions to the urethra, but these can be quickly severed with scissors.

Any hæmorrhage can be controlled readily by means of a gauze tampon placed firmly within the capsule. The entire operation is extremely simple and safe and quickly accomplished. Were it not for the troublesome drainage the suprapubic operation would be ideal.

The advantages of the perineal route mentioned above lie in the fact that the hæmorrhage can be easily controlled, the gland can be exposed to view, and there is ideal downward drainage. However, the method is too complicated and tedious to perform in patients in whom the margin of safety is very small at best and it should not be done except by the surgeon who has become expert through much experience.

The following method which I have employed in a large number of cases contains all of the advantages and none of the disadvantages of the two methods just described.

The patient is given a hypodermic of one-quarter grain of morphine and one-hundredth grain of atropine, half an hour before the ether is administered by the drop method. Everything is in readiness so that no time whatsoever is lost from the beginning of the anæsthesia to the end of the operation.

The bladder is irrigated with permanganate of potash solution, and a sufficient amount is left in the bladder to cause it to be moderately distended but not sufficiently to cause a possible rupture. The patient is then placed in the lithotomy position and a grooved sound is introduced into the urethra down to the perineum.

An incision is then made corresponding to the lateral incision formerly practiced in the operation of perineal lithotomy, extending from a point half-way between the scrotum and anus, to a point half-way between the left tuber ischii and the anus, and extending down into the membranous urethra which is opened at this point sufficiently to admit the point of an old fashioned lithotomy knife. The sound together with the lithotomy knife are passed into the bladder, care being taken to carry the sound along the pubic bone in order to prevent the knife from cutting into the rectum, thus splitting the membranous and prostatic urethra posteriorly. The knife is

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[1] Read before the Chicago Surgical Society, February 6, 1919.

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IMPORTANT POINTS RELATING TO THE SURGICAL TREATMENT OF PROSTATIC HYPERTROPHY

BY ALBERT J. OCHSNER, M.D.
OF CHICAGO

ALTHOUGH it is practically impossible to determine the number of deaths attributable directly to hypertrophy of the prostate gland, it is a well-known fact that the number is enormous. A large proportion of these cases are classed under pyelitis, chronic nephritis, uræmia and pneumonia because these are the terminal conditions, which would, however, not have occurred except for the effects of the obstruction due to the prostatic hypertrophy with its secondary conditions.

All of these secondary conditions are due to a simple mechanical obstruction, and the question arises, Why is this obstruction permitted to continue? The diagnosis is easily made, the discomfort of the patient is sufficient to cause him to seek the physician's advice, and the prognosis without relief is sufficiently grave to warrant radical treatment.

Why is such treatment not an almost universal practice? There are a number of potent reasons. First, patients at the age at which this condition becomes troublesome are, as a rule, not good surgical risks; consequently, the surgeon's reputation is likely to suffer if he undertakes these operations readily. The elements of risk come, first, from shock; second, uræmia; third, loss of blood; fourth, anæsthesia; fifth, post-operative pneumonia, and, sixth, sepsis. Aside from this risk there is also the discomfort from post-operative conditions, such as the long-continued drainage and incontinence of urine.

All of these conditions can, however, be greatly modified, if not eliminated also completely, if the method of treatment about to be described is carefully followed.

The shock in these patients seems to be due to exposure to long-continued operation, rough manipulation, and loss of blood. After the introduction of the suprapubic method by Freyer, which reduces the time of operation to a fraction of the time consumed formerly, the element of shock was eliminated to a marked extent. This element is still further reduced by the operation about to be described. The danger from loss of blood has been reduced by proper tamponing, that of post-operative uræmia, by irrigation of the bladder continued for a period previous to the operation, and by preliminary suprapubic drainage. The danger from anæsthesia has been reduced by reducing the time of operation, by giving the patient a proper hypodermic dose of morphine and atropine previous to giving the anæsthetic, if general anæsthesia is used, and by the use of spinal anæsthesia. The same plan of treatment and placing the patient with the head of the bed elevated from 12 to 18 inches immediately after the operation, and having the patient accustomed to lying in bed before the operation, reduces the danger from pneumonia. All of these methods together with the method of operation have practically eliminated the danger from sepsis, because the trauma is reduced to a minimum and the drainage is ideal.

There is no doubt but what in the hands of expert operators any one of the operations that have been described during the last few years will result in a recovery in a very high percentage of patients, and that by applying these operations regularly in all cases suffering from obstruction many years could be added to the lives of men who now die directly or indirectly as a result of prostatic hypertrophy.

The method to be described contains all of the advantages of all of the various methods with a less number of disadvantages. It consists in the following steps:

The patient is properly prepared by vesical irrigations continued for some days or even weeks before the operation is to be performed. The urine is disinfected by the administration of urotropin; five grains dissolved in a glass of water and given every three hours has usually been found sufficient. In cases that are not suitable for any considerable operation, even after the above preparation, suprapubic drainage should be employed for several weeks previous to the removal of the prostate.

Steps of the Operation.—The patient is given a hypodermic of one-quarter (¼) of a grain of morphine and one-hundredth (1/100) of a grain of atropine, half an hour before the ether is administered by the drop method.

Everything is in readiness so that no time whatever is lost from the beginning of the anæsthesia to the end of the operation.

The bladder is irrigated with permanganate of potash solution, and a sufficient amount is left in the bladder to cause it to be moderately distended but not sufficient to cause a possible rupture.

The patient is then placed in the lithotomy position and after dilating the sphincter ani muscle a grooved sound (Fig. 1) is introduced into the urethra down to the perineum.

An incision is then made corresponding to the lateral incision formerly practised in the operation of perineal lithotomy, extending from a point half-way between the scrotum and anus to a point half-way between the left tuber ischii and the anus, and extending down into the membranous urethra which is opened at this point sufficiently to admit the point of an old-fashioned lithotomy knife (Fig. 2).

The sound together with the lithotomy knife are then passed into the bladder, care being taken to carry the sound along the pubic bone in order to prevent the knife from cutting into the rectum, thus splitting the membranous and the prostatic urethra posteriorly.

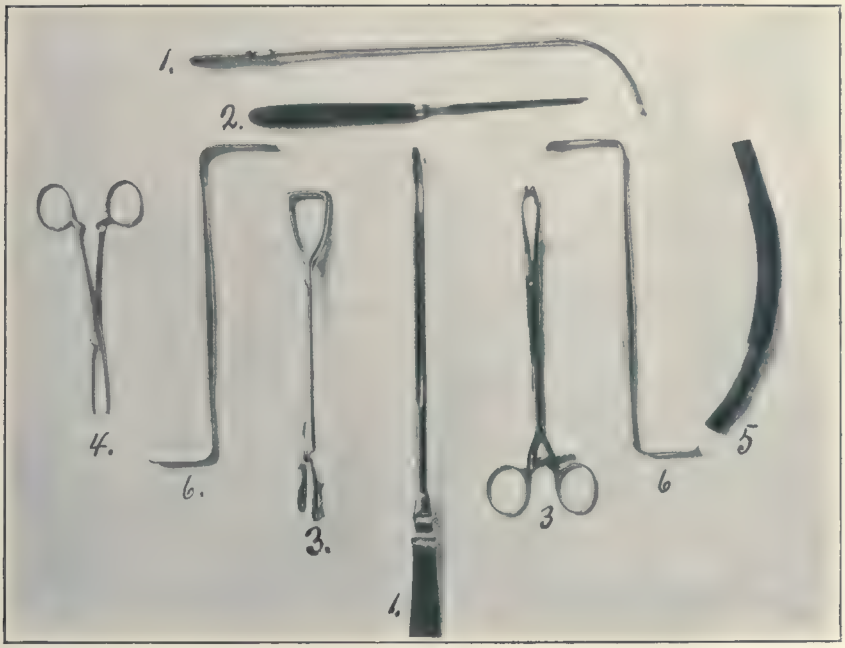

FIG. 1

The knife is then withdrawn, and the operator's finger is carried through the incision along the sound into the bladder.

The finger is now precisely in the same position in which it would be if a suprapubic opening had been made, and in this fact lies the important advantage of this over other methods of operation, because beginning from above and entering the capsule of the prostate gland through the urethra one is in a position to enucleate the prostate precisely as though the bladder were entered from above and through the usual suprapubic incision, and one were to enucleate the prostate gland according to the Freyer method.

This step of the operation should be carried out with the utmost care in order not to disturb the bladder or urethra unduly. If bands of adhesions are encountered, a pair of blunt curved scissors should be carried along the finger and these bands should be cut. Presently the entire gland is free from its attachments to the urethra, and the capsule and gland are withdrawn through the perineal incision by means of Dr. Hugh Young's forceps (Fig. 3). The area is then carefully explored with the finger and occasionally an additional lobule of prostatic tissue is found which has to be enucleated.

The index finger of the left hand is then introduced into the neck of the bladder, and the capsule of the prostate is caught by means of a fine-tooth forceps (Fig. 4), one being applied to the right and one to the left, and a drainage tube consisting of an inner tube 1 cm. in diameter covered in its middle portion by a second rubber drainage tube just large enough to slip over the first one (Fig. 5) is introduced into the bladder, the inner tube extending into the bladder, and the outer tube into the capsule.

Ferguson's retractors (Fig. 6) are then applied to each side. The capsule is held in position by means of the fine-tooth forceps, the gauze is packed around the rubber tube into the capsule. The double tube prevents collapse, and offers a sufficient amount of resistance to make the tamponing effective for controlling the hemorrhage.

The rubber tube is held in place by means of silkworm-gut sutures which pass through the edge of the wound and the outer rubber tube.

Two days after the operation the tube and packing are removed. Occasionally, one encounters a prostate gland which is hard and fibrous and cannot be enucleated. In this case it is removed by gnawing away piecemeal under guidance of the finger by means of the Ferguson gnawing forceps.

The entire operation can usually be performed in less than fifteen minutes. The shock is minimal, the amount of traumatism is not extensive, and drainage is downward through the perineum in the most comfortable and most effective position.

After the removal of the drainage tube and tampon the patient can sit up. After the fifth day the patient can take daily tub baths and within two weeks the urine usually begins to pass normally.

I am convinced that no one who has tried this method will hesitate to relieve these patients by operative treatment.

The use of the grooved sound and the old-fashioned lithotomy knife, the method of attack from above, and the method of drainage and the placing the tampon are the special features.

The older surgeons who have practised perineal lithotomy before crushing of stones and suprapubic lithotomy had displaced this method can appreciate the ease and safety of this method and the value of the grooved sound and the old-fashioned lithotomy knife with its blunt point and its cutting shoulder, which will cut the posterior wall of the membranous and prostatic urethra without injuring other tissues.

The bladder being open, the next important step consists in carrying the finger into the bladder and working from above downward, precisely as though one were performing a suprapubic prostatectomy.

The anæsthesia can be discontinued after the first incision has been made because the operation will be completed before the patient realizes any pain. A very small amount of ether is required for this operation.

The operation can be performed with great ease under spinal anæsthesia. It is well to dilate the sphincter ani muscle before beginning the operation in order to increase the comfort of the patient during the few days directly following the operation.

The after-treatment consists in the administration of an abundance of distilled water and the giving of light diet.

The tube and tampon are removed after two days and the patient is permitted to get out of bed. After the fifth day he is given daily tub baths also an ounce of mineral oil at bedtime.

In case there is a tendency to the accumulation of phosphates in the wound, the patient is given two or three drops of dilute hydrochloric acid in half a pint of distilled water every hour until the phosphates disappear.

The post-operative course of these cases and the results are as uneventful and satisfactory as were these conditions in the perineal lithotomies.

THE PRACTICAL VALUE OF ELECTRIC LIGHT IN THE TREATMENT OF INFECTIONS

By A. J. OCHSNER, M.D., LL.D., F.A.C.S., Chicago
Surgeon-in-Chief, Augustana Hospital and St. Mary's of Nazareth Hospital; Professor of Surgery, University of Illinois, College of Medicine

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September, 1918, pages 328-330

THE PRACTICAL VALUE OF ELECTRIC LIGHT IN THE TREATMENT OF INFECTIONS[1]

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THE object of this paper is to direct the attention of surgeons to the great value of electric light rays, especially because of their influence in controlling pain due to infection.

The rays of the sun have been used for many years, and various special light rays have been employed to a great extent, especially in sanitarium practice, usually by enthusiasts in whose judgment neither the general practitioner nor the surgeon has had reason to place great confidence. As a result of this circumstance, one has had the feeling that any apparent benefit probably came from the element of suggestion contained in the treatment. Most of the patients treated in these institutions are neurotics who require and demand some fad, and whether the light is red or blue or ultraviolet, the result is the same.

On the other hand, the treatment of infections by means of heat is as old as medical history. There is a certain degree of heat connected with all light treatment; consequently, whatever benefit was not attributed to suggestion could easily be attributed to the heat accompanying the light.

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[1] Read before the Chicago Surgical Society, March 1, 1918.

It is a well-known fact that there is a marked physical difference in the wave lengths of different light rays, and a difference in the length of waves caused by the heat obtained from heated objects and those obtained from light, and there is a corresponding difference in the depth to which these rays penetrate.

One could write a book on the differences existing between these rays and build up fine theories upon the effects of these differences, but my object is to set forth clinical observations and to leave the physics of the subject to others.

Four years ago, when I suffered from a violent infection of my elbow, it became necessary to expose the ulnar nerve when the abscess was laid open. This gave rise to intense neuralgic pains which continued for many days without cessation, notwithstanding the use of wet and dry heat.

At the suggestion of Dr. Saurenhaus, I applied an electric light apparatus similar to the one shown in the accompanying figure. Within an hour the pain disappeared, not to return.

My natural skepticism regarding the effect of therapeutic measures led me to think this might be due to coincidence, and that possibly the pain might have subsided at this time had we not employed the electric light.

During the past four years, however, I have had an opportunity to test this method at the Augustana Hospital in 78 similar cases of infection of the extremities, and invariably the pain has disappeared promptly. Sixty-one of these cases were infections of the upper extremity, and 17 of the foot.

In order to illustrate the type of cases in which the use of electric light is especially valuable, I will quote the history of an illustrative case now under my care at the Augustana Hospital.

Mrs. L. P., age 64, Case No. 53451, admitted February 7, 1918. Family and past history unimportant.

Present complaint. Eight weeks ago the patient's little finger became infected. It grew red and became swollen, the swelling involving the entire hand and forearm. The third finger was markedly involved. During the past seven weeks the little finger, the third finger, the palmar and dorsal surfaces of the hand were lanced seven times, four times producing pus, and three times serum. There has been much pain in hand and arm during the entire time. Some slight soreness was noticed on third day of infection in the axilla. The treatment has consisted in free incision of areas suspected of containing pus, and thorough drainage by means of iodoform wicks, and the application of large moist boric acid dressings.

Immediately after admission the patient was placed in bed, a large moist dressing was applied and covered with rubber cloth, the forearm and hand were placed on a splint, and the electric light was applied. A small amount of fresh, hot boric acid solution was poured into the dressing every three hours, sufficient to keep it wet. The electric light was kept in action night and day. The dressings were changed every forty-eight hours.

Within an hour after the application of the electric light this patient was free from pain, and she has remained free. Within twenty-four hours after beginning this treatment the facial expression of the patient has changed from that of a discouraged, severely ill person subjected to extreme suffering, to one free from pain, contented and hopeful. The wounds improved rapidly. Within the first week the sloughing tendons could be removed without pain.

In the meantime we continued the use of large moist dressings covered with rubber cloth, adding a small amount of the fluid every three hours to keep the dressings moist. The hand and forearm were immobilized by means of a splint placed underneath the forearm and hand, and the hand was carefully supported during the change of dressings. All unnecessary pressure and manipulations were avoided. The gauze drains which were present when she entered the hospital were removed at the second dressing and no new drains were inserted. The bone

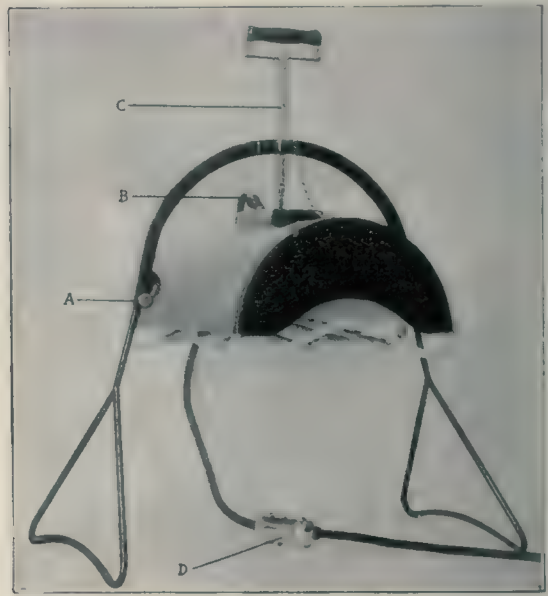

Fig. 1. Adjustable electric therapeutic light. *A*, Lock on folding stand; *B*, adjustable reflector; *C*, rod for elevating and lowering reflector; *D*, button for regulating number of lights used.

of the second phalanx of the third finger was removed at the second dressing, as it was perfectly loose in its place.

Our experience has been practically the same in all of our cases of this class, and

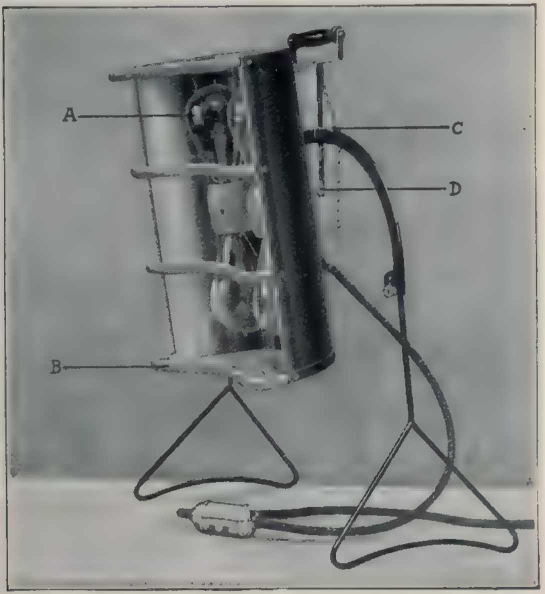

Fig. 2. Reflector adjusted for treatment of side of patient.

neither we nor our patients would be willing to get on without the use of light in these cases.

We have had equally satisfactory results in the use of the electric light in treating peritonitis following abdominal sections for the relief of suppurating conditions such as appendiceal abscesses, perforated gall-bladder, etc., also in tuberculous and gonorrhœal joint infections, in carbuncles and furuncles.

In case of X-ray burns the light treatment causes a rapid improvement of the condition, and one of my assistants who had an opportunity of treating many patients suffering from frozen extremities, assured me that his results were much better with electric light than with any other form of treatment. George W. Crile reported that in many French hospitals infected wounds are exposed to the continuous rays of ordinary electric light bulbs. He was impressed with the fact that there was a marked decrease in pain, and that wound healing progressed very satisfactorily under this form of treatment.

I would strongly urge all of my colleagues to give this treatment a careful trial, and I am confident that all will adopt it. I believe that the general introduction of this form of treatment of septic wounds, especially of extremities, in army hospitals would result in great reduction of suffering, as well as a rapid improvement in the condition of the wounds.

The apparatus which we have found most useful consists of a simple reflector underneath which one or two ordinary electric light bulbs are suspended. The amount of heat can be varied by changing the bulbs to increase or decrease their candle power.

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STONE IN THE KIDNEY AND URETER

From the Standpoint of the Clinical Surgeon

A. J. OCHSNER, M.D.
CHICAGO

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STONE IN THE KIDNEY AND URETER

FROM THE STANDPOINT OF THE CLINICAL SURGEON *

A. J. OCHSNER, M.D.
CHICAGO

It would seem proper for me in my part of this discussion to avoid a repetition of what is contained in most of the special works as well as in the various monographs on stone of the kidney and ureter, which are so complete and exhaustive that, in connection with the recent papers by Braasch,[1] Eisendrath,[2] Young,[3], Cabot,[4] Eliot,[5] Merritt[6] and others, the field has been splendidly covered. It would seem well worth while, however, for me to consider stone of the kidney and ureter from the standpoint of the clinical surgeon, especially because I have been constantly active in the treatment of these cases since they have been looked on as surgical.

I assisted Prof. Charles T. Parkes[7] in 1887 in the diagnosis and operation of his first case, which was one of the earliest cases treated by operation in this country.

At that time, the characteristic symptoms, which are now generally accepted, were discussed incidentally in textbooks. Morrison had written on the sub-

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* Read before the Section on Urology at the Seventieth Annual Session of the American Medical Association, Atlantic City, N. J., June, 1919.

[1] Braasch, W. F.: Boston M. & S. J. **178:** 292 (Feb. 28) 1918; Lithiasis with Bilateral Renal Involvement, Minnesota Med. **1:** 252 (July) 1918.

[2] Eisendrath, D. N.: The Diagnosis of Ureteral Calculi, Surg., Gynec. & Obst. **27:** 461-468 (Nov.) 1918.

[3] Young, E. L., Jr.: Clinical Diagnosis of Lithiasis of the Upper Urinary Tract, J. A. M. A. **69:** 1490 (Nov. 3) 1917.

[4] Cabot, Hugh: Errors in Diagnosis of Renal and Ureteral Calculus, Surg., Gynec. & Obst. **21:** 403, 1915; Stone in Kidney and Ureter, a Critical Review of 157 cases, J. A. M. A. **65:** 1233 (Oct. 9) 1915.

[5] Eliot, E., Jr.: New York M. J., Dec. 1, 1906.

[6] Merritt, E. P.: A Consideration of Ureteral Stones, Surg., Gynec. & Obst. **27:** 538 (Nov.) 1918.

[7] Parkes, C. T.: Clinical Lectures, Chicago.

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[6] Merritt, E. P.: A Consideration of Ureteral Stones, Surg., Gynec. & Obst. **27**: 538 (Nov.) 1918.

[7] Parkes, C. T.: Clinical Lectures, Chicago.

ject and reported cases. Israel was beginning the work in this department which has since brought him international fame, and Jacobson had given some attention to the surgical importance of this subject which had been mentioned by various surgeons in connection with occasional clinical observations.

The stone in the first case of my experience, mentioned above, was the shape and size of a robin's egg, was perfectly smooth and fitted like a valve into the entrance of the ureter, accounting perfectly for the pain and symptoms of obstruction and for the thickened walls of the pelvis which made location of the stone by palpation impossible. The stone was located by puncturing with a fine sewing needle, which was generally recommended at that time, but which has since been discarded because it leads frequently to the missing of small stones.

My next observation of especial importance occurred in 1888, when I was directed by my chief to keep a colleague under the influence of chloroform at intervals from 10 a. m. to 8 p. m. while a renal calculus was passing through the ureter. For several years, this physician had passed from one to three renal calculi annually. Morphin had no effect on him and the pain was unbearable, so the use of anesthesia was our only hope of giving relief.

A few days later, before this patient had time to produce another calculus, we met another one of Professor Parkes' patients who had suffered from recurrent renal colic, a manufacturer of steam boilers. On asking him whether he had experienced any attacks recently, he stated that he was definitely through with renal colic, and suggested that if the doctors used their intelligence as actively in their profession as boiler manufacturers had to in their business, no one would ever have to experience a second attack unless he had more than one stone in his kidney to begin with. He stated that when his customers complained of their boilers filling up with lime in the form of scales, he advised them to use rain water, and this ended the trouble; so on the same principle he drank freely of distilled water, and had been free from a recurrence of kidney stone and renal colic.

I immediately put our colleague on this treatment, which he continued for twenty-nine years, never having another attack. He died of cerebral hemorrhage at the age of 74.

Since that time, I have made use of this method in an enormous number of cases, always with the same result; and the practice has been followed by many practitioners who have visited my clinic and others who have read about this method of treatment. I have no doubt that the method must have been used before the boiler maker discovered it, but earlier reference to it has escaped my attention, except that the water from certain springs which is almost as free from lime as is distilled water has been used as a prophylactic against recurrence of renal colic from time immemorial, while regions in which the drinking water is loaded with lime salts are notorious for the frequency of renal calculi, as cited by O. S. Fowler,[8] for instance, in India.

A number of observations similar to the following have proved the importance of this treatment:

Case 1.—A farmer, aged 34, from the limestone region of Wisconsin, came to my clinic suffering from recurrent renal colic twenty-seven years ago. During former attacks, he had obtained relief spontaneously, but this attack seemed more severe. The stone passed on the second day under treatment with morphin and atropin hypodermically, and 2 ounces of glycerin and large quantities of distilled water, all of which were repeated after twenty-four hours. He obtained a distilling apparatus and drank only distilled water for twelve years without having any further attacks until he drank well water for six months, being too much occupied while building a new house to take the distilled water. This brought on another attack, during which he passed a calculus 1.5 cm. in length. He immediately returned to the use of distilled water and has now been free from attacks for fifteen years.

I have encountered a number of similar cases.

There is a marked difference in opinion as regards the proportion of cases in which renal and ureteral stones will pass spontaneously, some placing the percentage as high as 90, while others place it as low as 10 per cent. (Merritt,[6] Braasch[1]).

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8. Fowler, O. S.: Ureteral Obstruction Causing Urinary Stasis, a New Etiology in Kidney-Stones with a New Method of Nephropexy to Secure Ideal Natural Drainage, J. A. M. A. **62**: 367 (Jan. 31) 1914.

This depends, of course, very largely on the class of cases treated. In our clinic the patients who come from the immediate city or vicinity usually have stones that pass under the treatment mentioned above. In all probability, the stones that passed following this treatment would have passed spontaneously before the patients could have traveled a long distance so that only those patients come from a distance whose stones cannot pass for one reason or another, and therefore clinics which receive their patients almost exclusively from long distances must have a far larger percentage of cases requiring operation than clinics in municipal hospitals.

My next case of especial interest, which I saw in 1892, demonstrated a fact which is now mentioned in most articles, and in practically all textbooks treating on this subject:

Case 2.—A powerful, healthy appearing man, weighing over 200 pounds, about a week previously had begun to suffer from pain in the region of the right kidney which had increased constantly, no relief being obtained from the hypodermic use of morphin. It was thought that the typical uremic convulsions to which he succumbed almost immediately after I saw him were due to the pain, which was confined to the region of the right kidney.

The physician in charge felt certain that the patient had not previously suffered from nephritis and could not account for the uremic convulsions. The necropsy revealed absence of the left kidney. The pelvis of the right kidney contained a pear shaped stone, 2.5 cm. long, with the portion corresponding to the stem inserted in the upper end of the ureter. A pyelotomy during the early stage of the attack would, of course, have cured the patient as has been demonstrated in many cases since that time.

Case 3.—A woman had a sinus, leading to a nephritic abscess of the right kidney from which a stone had previously been removed, which refused to heal under treatment. In the meantime, the fistula had drained much urine and pus, while the amount of urine secreted by the other kidney, although it remained normal in quality, decreased constantly until less than 100 c.c. were voided daily. After keeping the patient under observation for a sufficient period, and finding it impossible to pass a ureteral catheter into the pelvis of the right kidney, we decided to remove the organ because we attributed her failing health to absorption of septic material, and at the rate she was losing strength, we felt certain that she could not last very long.

Within two days after the operation, the urine passed from the bladder increased markedly, and within two weeks it increased to 800 c.c. This showed in a very marked degree the fact that the remaining kidney is stimulated to greater activity on the removal of the diseased organ, the justification of which has now been thoroughly established.

The next case marks the beginning of a change in the practice in our clinic:

Case 4.—A woman, aged 60, emaciated and septic in appearance, with typical symptoms of double pyonephrosis with multiple calculi, was treated by drainage of the left kidney and the removal of a number of stones; a month later the right kidney was treated in the same manner. Both kidneys were tuberculous. The patient was put under hygienic and dietetic conditions, but lost in weight and strength very slowly but gradually. Formerly, no patients of this type had ever recovered in our experience, although we had a series of recoveries in cases in which we had removed one tuberculous kidney even after it had been drained for a time. In this case, both kidneys were in such bad condition that it seemed out of the question to remove one. We consequently started to fill the sinuses and the pelvis with a paste of 20 per cent. bismuth subnitrate in petrolatum, repeating the treatment once a week. The patient showed improvement within a few weeks, increased in weight and strength rapidly, and made a complete recovery.

Since that time, we have invariably treated sinuses leading to tuberculous kidneys with Beck's bismuth paste with a fair number of recoveries.

During the fifteen years ending Jan. 1, 1919, I have treated 146 cases of kidney and ureteral stone in my clinic at the Augustana Hospital.

TREATMENT

In case the calculus lies in the pelvis without several branches into the calices, we have found pyelotomy most satisfactory, following the advice of J. B. Murphy,[9] whenever possible, of first splitting the upper end of the ureter longitudinally and continuing the incision into the pelvis.

In branching stones, we have clamped the pedicle of the kidney lightly, split the cortex longitudinally just behind its midline, removed the stone, and placed heavy catgut sutures through the kidney, tied just tightly enough to bring the surfaces together, and then released the clamp. In pyelotomy, only in cases in which the edges of the pelvis failed to fall together evenly, fine catgut sutures were used. In either case we drained the wound with a strand of gauze and a cigaret drain.

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[9] Murphy, J. B.: Surgical Yearbook, 1907.

Ureteral stones which could not be delivered through the bladder without traumatizing the ureter, we have removed through an abdominal incision in the linea semilunaris carrying a small rubber drain, a narrow strip of gauze and a cigaret drain through the lower angle of the wound down to the incision in the ureter. In none of these cases have we applied sutures. Only in one case have I removed a stone through a vaginal incision.

CONCLUSIONS

1. The size of the pelvic stone will usually determine the possibility of its passing spontaneously.
2. In the ureter, the primary stone, if it gets started, will usually pass. Secondary stones may be stopped by cicatricial contractions which may have been caused at some point by injuries due to the passage of one or more previous stones.
3. A large proportion of stones of moderate size will pass spontaneously or after dilatation of the ureter with bougies, the use of oil of glycerin injections or one of the various methods of dilatation, of which the one perfected by Lespinasse[10] seems most effective.
4. At times, simply starting the stone with a bougie will suffice.
5. In patients suffering from acute renal colic, the use of morphin and atropin hypodermically followed by the ingestion of 2 ounce doses of glycerin with large quantities of distilled water has seemed to be of value in aiding the passage of stones spontaneously, especially when the patient was immersed in a very hot bath.
6. The prophylactic measure of taking large quantities of distilled water seems to be effective in preventing recurrences.
7. Sinuses remaining after pyelotomy or nephrotomy will frequently heal after injection with Beck's bismuth paste.

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[10] Lespinasse, V. D.: Surg., Gynec. & Obst. **26**: 631 (June) 1918.

8. The clinician who is alert for the discovery of renal or ureteral stone, who takes into consideration the history and physical findings, will rarely miss a correct diagnosis provided he confirms his diagnosis (*a*) by careful urine examination; (*b*) by roentgenographic examination with intensified shadows if necessary; (*c*) by the introduction of ureteral shadow sounds; (*d*) by pyelography in doubtful cases, and provided he is willing to consider all points as a whole and will place no weight on negative findings by any single one of the various methods employed.

DIAGNOSIS

The most important element in the diagnosis is a carefully written history taken by the surgeon himself who is thoroughly familiar with the clinical courses of these cases, because the careful weighing of all the points elicited is exceedingly valuable, while each individual element in the history may be of but slight value.

This accounts for the constancy with which the older clinical surgeons have their diagnosis confirmed by the roentgenographic and other laboratory findings, and also for the fact that we find in the literature so many of the younger surgeons and diagnosticians who lay little value on the history.

It is certain, however, that wide clinical experience must confirm the conclusion arrived at by Young[8] after his extensive studies, that "no single piece of evidence or combination of evidence is sufficient to make an absolute diagnosis."

Next in importance is the roentgenographic examination. The plate should show a distinct picture of the outline of the kidney to be dependable in case of renal calculus.

In case the shadow is not sufficiently distinct, the latter should be intensified.

In case there is doubt concerning the stone's being in the ureter, a shadowgraph catheter should be introduced.

Of course the bowels should be thoroughly emptied before the roentgen ray is employed, and both kidneys should be examined, because, according to Braasch,[1] in bilateral stone the pain is unilateral in 64 per cent. of the cases. Guyon pointed out the fact many years ago that a stone in one kidney may give rise to pain on the opposite side exclusively, a condition he termed "renorenal reflex."

Cystoscopic examination is especially useful in differentiating between calculus and tuberculosis. The same thing is true of microscopic examination of stained urinary sediment and inoculation of guinea-pigs for tuberculosis.

Lucas,[11] in one of the early works in this field, invented an interesting test for ureteral calculus which has not received due attention. The thigh is held in a flexed position resulting in contraction of the iliacus muscle, which is relaxed suddenly, jarring the ureter containing the stone and causing acute pain. He also gives the following symptoms not usually mentioned: Patients with calculi often have a tendency to micturate frequently during the daytime, while at night they are not disturbed.

In case of obstruction of the pelvis or ureter of the only remaining kidney, the patient in making frequent unsuccessful attempts to micturate develops headache, vomiting and uremia.

He gives the following points for differential diagnosis between tuberculosis and calculus:

Hematuria without pain appears early in tuberculosis; hematuria with pain is constant in calculus.

Pyuria without pain appears early in tuberculosis; pyuria with pain appears late in calculus.

Pus is present in tuberculosis in excessive amount; in calculus it is minimal in amount.

Pain in tuberculosis is diffuse, dull, constant; in calculus it is definite, sharp and intermittent.

Chills in tuberculosis are common; in calculus they are rare.

There is rise of temperature in tuberculosis especially in the afternoon; in calculus it is rare.

Tubercle bacilli in tuberculosis are sometimes present; in calculus they are absent.

The ureter is thickened in tuberculosis, sometimes it is palpable; in calculus it is not palpable.

The remaining conditions to be considered in making a differential diagnosis are movable kidney, oxaluria, acute granular nephritis, papilloma in the pelvis,

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11. Lucas, R. C.: Lancet, April 25, 1903.

tumor, gallstones, tuberculosis of the spine, appendicitis, ectopic gestation, sciatica and lumbago, stone in the opposite kidney, seminal vesiculitis, pyosalpinx, and gastric or duodenal ulcer. Phleboliths and calcified tuberculous lymph nodes may be mistaken for stones when one is attempting a differential diagnosis.[12]

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[12] In addition to the references already given, the following will be found of interest:

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THE MALARIA QUESTION AND THE FARMER

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*I am greatly interested in Southern agriculture, because my son has a great plantation in Virginia and is assistant animal-husbandman in the U. S. Department of Agriculture under Mr. Jones, of the State of Virginia. We have tried out this plan thoroughly in Surry County, Virginia, where we have a colony of university men owning a large number of farms. I am sure that the plan, if generally adopted, would mean an enormous increase in wealth for the Southern farmers.**

Many of the most fertile farming districts in the United States are infected with malaria, which is most troublesome during the portion of the year when uninterrupted farm labor is most needed. This condition has been an important draw-back to agriculture. The amount of farm produce lost directly because the workers on these farms are ill from this malady is enormous; but this is as nothing when compared with the amount which could and would be raised were men not afraid to undertake farming in these regions because of fear for their own health and the health of their families on account of the presence of malaria.

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*Paragraph from a personal letter to the Editor.

The subject of malaria, then, is not a problem for the physician to consider so much as it is a question for the farmer. Malarial districts as a rule are not desirable locations for the physician because the general prosperity and wealth of these communities is usually comparatively low and one can not develop a lucrative practice except in a prosperous community.

It is a well-known fact that malaria is acquired only from the bite of a mosquito, most commonly of the anophiles variety, that has previously bitten another person who at that time carried in his blood the parasite known as the plasmodium of malaria. In order not to acquire malaria one must consequently protect himself against the bite of this species of mosquito, or if this is not possible one must be bitten only by mosquitoes that have not previously bitten any one having these malarial parasites in his blood. Is it possible to obtain this protection?

In the *Geographic Magazine* for September, 1917, Surgeon-General Rupert Blue, of the United States Public Health Service, has shown clearly how this has been accomplished in many parts of the United States in order to provide safe conditions for our soldiers in the various cantonments. It is, however, plain that aside from making use of ditches and drains in order to clear up marshes and ponds and straighten brooks, it will not be possible as a rule to free the farms entirely of breeding places for mosquitoes; neither will it be possible to kill the young mosquitoes by the application of crude oil on the farms because of the expense involved.

Is it within our power to provide against the possibility of being bitten by mosquitoes that have previously bitten persons carrying the malarial parasite in the blood aside from what can be accomplished by the careful screening of houses? M. B. Mitziam, in *Bulletin No. 84*, U. S. Public Health Service, 1916, reports observations in this direction which if properly utilized will be of the very greatest importance to the American farmer. He made a microscopic examination of 2122 anophiles mosquitoes collected in the State of Mississippi during the winter months. These mosquitoes contained no parasites. At the same time he examined the blood taken from 1,184 persons residing in the same district and found malarial parasites in 492, or nearly one-fourth of these persons, which would indicate that the human being is the carrier of these parasites during the winter. In the following spring when the mosquitoes which have hibernated again come on the scene, they can at once become infected and carry the parasite from the blood of the human carriers, who have harbored the malarial parasites all winter, to healthy persons.

If all of these healthy persons had taken the precaution during the winter to free their blood of malarial parasites, the bites of the anophiles mosquitoes during the following spring and summer would have been perfectly harmless.

Of course the introduction into any community, in which the anophiles mosquito abounds, of a single person whose blood is infected would naturally cause a fresh outbreak of the disease. It happens that many persons carrying malarial parasites in their blood are perfectly healthy so far as their appearance is concerned and they show no symptoms indicating that they are malaria carriers. It is only by means of a microscopic examination of the blood that one can determine the fact that they are indeed carriers of malaria.

In order, then, to free a community from the danger of being bitten by mosquitoes that have previously bitten malaria carriers, it would be necessary to examine the blood of every person living in a malarial district and destroy the parasites in the blood of all of those found infected, preferably during the winter months while reinfections can not occur because of the absence of mosquitoes; or in communities in which no competent physician is located who can make a satisfactory examination of the blood the whole community may be subjected to this treatment, inasmuch as it is not harmful to the person and does not cause discomfort nor incur much expense.

The following treatment has been thoroughly tested, is efficient and simple, and fills the requirement just stated. Even if an entire community can not be induced to employ this plan it can be used to great advantage on any farm or plantation, and if used simultaneously by a number of neighboring farmers located in a malarial region, their improved health will soon induce other farmers to follow the plan.

If generally carried out this plan would add hundreds of millions of dollars to the wealth, especially of our Southern states, and infinitely to the health and comfort of its inhabitants.

TREATMENT OF MALARIA

The following rules are based upon a number of well-known facts:

1. The adult plasmodium of malaria is destroyed in the blood of a patient saturated continuously for forty-eight hours with quinin.

2. The spores of malaria can live indefinitely in the blood of patients without regard to the amount of quinin taken.

3. Spores of malarial plasmodia remain latent in the presence of quinin in the blood and begin to develop only after this drug has been entirely eliminated.

4. These spores require seven days before they can develop into adult spore-bearing plasmodia.

5. Quinin must be absorbed in order to do its work. Hence the importance of the preliminary cathartic, the soup diet and the hot water taken with the quinin.

6. The blood must remain continuously saturated with quinin. Hence the importance of giving the remedy regularly night and day.

7. The total amount of quinin required is very small.

CONCISE METHOD OF TREATMENT

Follow every step absolutely. Do not miss taking the medicine at regular times at night. Use an alarm clock if necessary. Take the medicine with hot water to insure immediate absorption.

On the evening before commencing the use of quinin, take a cathartic, preferably two ounces of castor oil in beer-foam or ginger ale or root beer; or take five grains of calomel with ten grains of bicarbonate of soda at bedtime and a Seidlitz powder the following morning.

During the period of treatment it is best to live on hot soups. On the morning following the taking of the cathartic, take two grains of quinin — bisulphate preferred, but the sulphate or the muriate will do—with half a pint of hot water every two hours night and day for two full days and two full nights. Be sure to do this regularly because missing once or twice will make the treatment useless.

Then give absolutely no quinin for six full days and six full nights. On the evening of the sixth day take another cathartic. On the morning of the seventh day begin taking the quinin again, two grains every two hours night and day for two full nights and two full days. Then stop and take some simple tonic for a few weeks and keep away from mosquitoes that have bitten others suffering from malaria.

You may use the quinin in solution or in capsules, but in the latter case you must remove the cap from the capsule before swallowing it.

In the interval of six days between the two courses of quinin treatment it is well to take a pill containing 1/50 of a grain of arseneous acid one hour before and after each meal, each time with a glass of hot water.

The following prescriptions are usually followed by these patients if one is emphatic in explaining the necessity of obeying absolutely.

In case the quinin disagrees with the patient it is usually possible to correct this difficulty by giving 2 to 5 grains of sodium bromid in a little hot water before administering each dose of quinin.

Rx.

Quininae Bisulph. in capsul. (aa gr. ij) No. 100.

Sig.

Take one with one-half pint of hot water every two hours night and day for forty-eight hours on first, second, ninth and tenth day. Remove cap of capsule before taking.

Rx.

Pil. arseneous acid (aa gr. 1/50) No. 36.

Sig.

Take one with a cup of hot water an hour before and after each meal on third, fourth, fifth, sixth, seventh and eighth day.

The Correction of Fractures after Application of Plaster Casts

BY

WILLIAM M. HARSHA
M.D., F.A.C.S,

CHICAGO, ILLINOIS

Read before the
Western Surgical Association
December 20 and 21, 1918

THE CORRECTION OF FRACTURES AFTER APPLICATION OF PLASTER CASTS

William M. Harsha, M.D., F.A.C.S.

CHICAGO, ILLINOIS

It seems to me that treatment of fractures with plaster casts has gone very largely into the discard in the last few years. The reason for it is, that probably with the introduction of more accurate methods of approximating fractures with bone plates, wires, pegs, etc., surgeons have paid less attention to the closed method in applying mechanical principles and in seeking for all the devices we have had for the treatment of fractures before operative measures were introduced.

I have not had a large experience in operating for fractures. I have done a moderate number of operations. I have seen a good many fractures treated by different methods, including the use of the Lane plate by Mr. Lane; but in the past year or two the experience and observations I have had have led me to think that in too many cases of fractures we have operated. Of course, we have to admit that there is a need and a place for the operative treatment of fractures. There are cases of ununited fracture in which we have to operate in one way or another. There are other cases in which with our best efforts we are unable to get such an approximation as we would like, so that there will always be a place for the open method of treatment; but my contention is, that the cases of fracture that will not yield to some form of mechanical device in treatment are few.

The cases that I wish to show you are some that have come under my care in the last two or three months in my surgical service at St. Luke's Hospital. I am going to show you some pictures and try to explain them as we go along.

Case 1.—The first case I show you is a man, aged 40, who was run over by a heavy auto truck, the wheels passing over both thighs producing comminuted fractures of both femurs, involving the middle and lower thirds. This (showing slide) shows the method we employed in putting him up in plaster. (Plate 1.) The Hawley table is a distinct aid to us in getting extension and counter-extension. You will see that these arms are supported by this device which counter-extends at the crotch. There are two arms, one goes to either side, and they suspend the legs at the knees. The plates I show you will enable you to see the involved sites very well, above, or at about the junction of the middle with the upper third, and from that point almost to the knee-joint, as you will see by the *x*-ray plates. It was out of the question, it seems to me, to plate a fracture of that kind. This man was in profound shock. There was no compound fracture, but both thighs were smashed, so that if you lifted them up you could feel the bones rattle around. We put him up on a Hawley table, with extension on each leg, under the influence of ether, which would permit the handling of the patient in a satisfactory way. We put a cast almost up to the ribs; at any rate, it was well above the hips.

There is one point I should mention in connection with supporting the thighs. Unless you have a great deal of extension upon each leg, with two, three, or four pieces of bone in here (indicating), before the cast gets dry this part will sag unless there is support under the thigh. I have an assistant hold this up (indicating) while the plaster is setting, one on either side, because at this stage, when it is ready to dry, without that support it would probably sag.

This (showing slide-Plate II) is an anteroposterior view of the left thigh before it was put up in a cast, and the next slide (Plate III) shows you an anteroposterior view after the plaster cast was put on. The next slide gives you a lateral view of the same leg with cast applied. (Plate IV.) The next plate shows a lateral view after cutting and slightly bending the cast. (Plate V.)

Here I want to illustrate the method of making better apposition of these fragments without taking the cast off. If you take the cast off and put it on again, you cannot be sure of a better result at the next trial; with the cast on you have the fragments fixed, and can bend the cast where it is needed. You will see a difference in the alignment and a difference in the tilting of the lower fragments.

The method of correction consists in making a clean circular cut three-quarters of the way around the cast on the *concave* side. This point here (indicating) is separated from this point. After it is cut three-quarters of the way around I leave enough of the cast to make it fairly firm. That would bend there, but we did not bend it far enough so that it would break. You notice the difference in alignment. This patient has a fine functional result. He entered the hospital on the 9th of October last. This slide shows an anteroposterior view of the right thigh. (Plate VI.) That is the way it looked before it was put up, showing two pieces of bone in the middle portion. Here is a lateral view (Plate VII) and the other is an anteroposterior view after it was put in the cast. (Plate VIII.)

When should we put a cast on a limb after it has been fractured? In the first place, after a subsidence of the swelling the limb is reduced in size, may be 15 per cent. You also know that after a limb has been up in plaster for a week or two it shrinks nearly 10 per cent from disuse, and then the cast does not fit.

In putting this up originally with the Hawley table, I relied on the grasp of the cast, the flexion of the legs at the knees, and the body cast supported by the hips for my extension and counter-extension. It worked perfectly on the left side, as the measurements of the leg showed in three weeks. It did not work perfectly on the right side.

When the cast was applied there was a great deal of swelling. In three weeks the swelling subsided, and there was the usual shrinkage of the limb from disuse. The cast, together with the flexion at the knee, did not prevent displacement. The pain increased, which is always an indication that there is mobility or displacement.

We cut away the anterior half of the cast longitudinally up to the hip, applied extension with adhesive plaster, padded the sides of the limb, and reapplied the plaster cast, including the under or posterior half that was left. The leg now shows but half inch shorter than its fellow, and union is taking place, the extension (fifteen pounds) being discontinued.

In a simple fracture with little swelling the cast, plus flexion at the knee, will hold the fragments in position. It may be better in all such cases, however, to provide for extension with moleskin plaster to be used if needed.

Case 2.—This patient is a man, 65 years of age, who entered the hospital about the first part of November. (Plate IX.) He was knocked down by an auto, and sustained a fracture at the surgical neck of the humerus. This is the photograph after the application of the cast. (Plate X.) It shows the method by which it was put up. This is not new, but I find few surgeons are using it at the present time. I have

Plate I

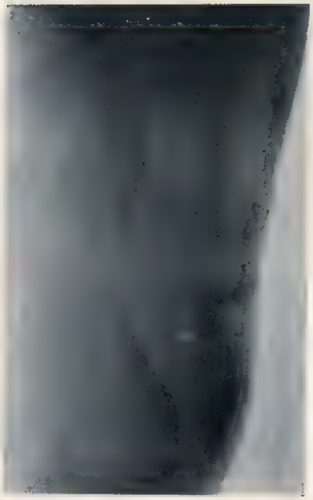

Plate II

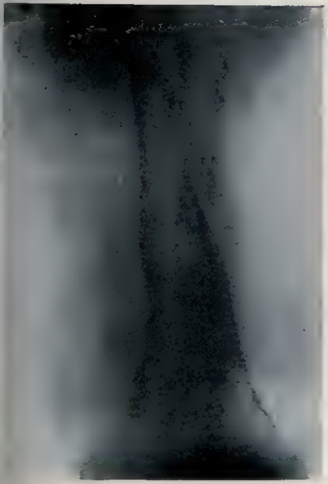

Plate III

Plate IV

Plate V

Plate VI

Plate VII

Plate VIII

Plate IX

Plate X

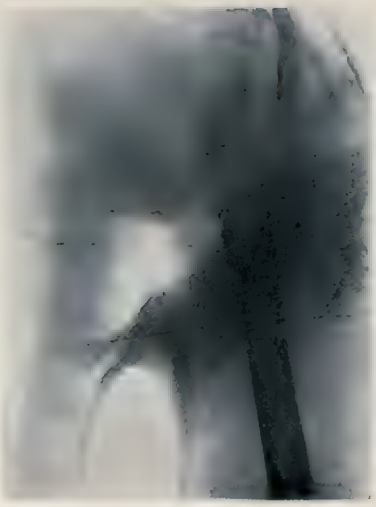

Plate XI

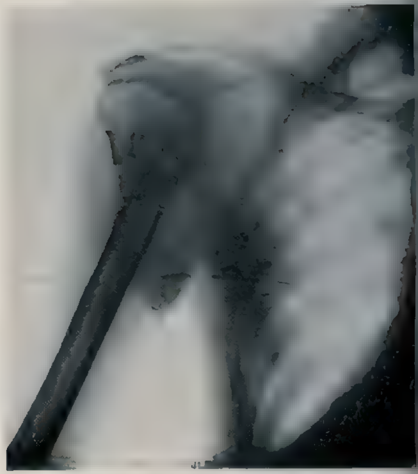

Plate XII

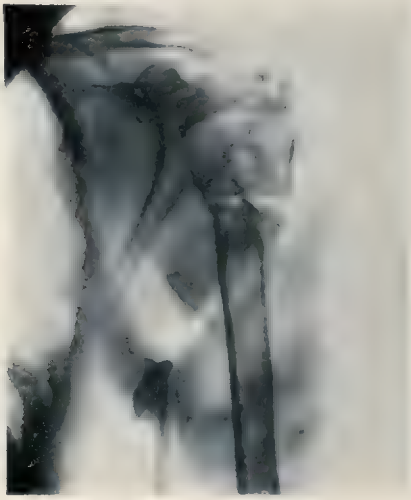

Plate XIII

Plate XIV

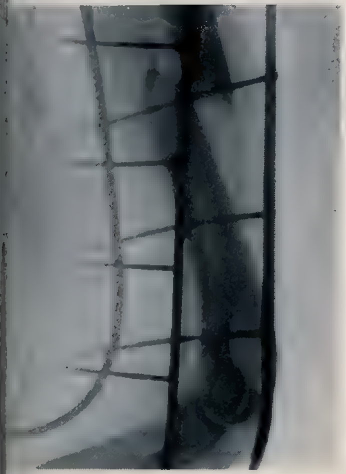

Plate XV

Plate XVI

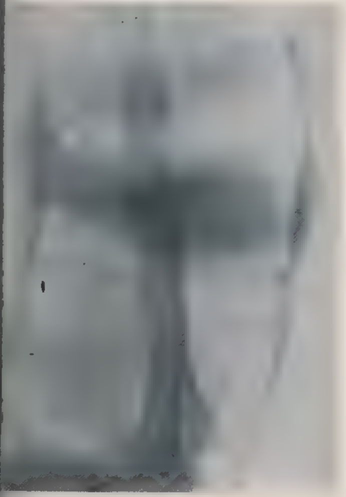

Plate XVII

Plate XVIII

resorted to this method in half a dozen cases. It is pictured in Tillman's Surgery away back ten or fifteen years ago. In reducing the fracture the arm was abducted and rotated outward; we put moleskin adhesive plaster up to the level of the fracture on either side of the arm to maintain extension, and counterextension was made with a sling under the axilla over a big pad of cotton. Plate XI shows the *x*-ray after reduction. Of course, this is not as accurately approximated as you can do it with wire. However, I do not think wire would do much better than that, and the man has obtained an excellent result so far.

Case 3.—This man also sustained a fracture of the surgical neck the same as the last patient. The accident occurred on the 10th of May last, and it was treated somewhat like the other case, but with a moulded splint. He was treated at St. Luke's Hospital. He was laid up for a week or two, and it was difficult to keep it in position. He got a good result, and went along until the twenty-first day of last month when he had an encounter with a holdup man, and put up the best fight he possibly could, and came in with a refracture at the site of the old fracture. (Plate XII.) I do not know whether he has as perfect union as before, but the plate shows that he did have good union, and the function seems to show it. I show you a picture after the cast was put on. (Plate XIII.) It shows something of the old injury. You see the fractured edges are quite well apposed, except a slight separation. This was put up in the same body cast. This man was 54 years of age, an accountant, who is now able to conduct his business and to use his hand with comfort; and I recommend the body cast, not only in the treatment of fractures of the surgical neck and shaft of the humerus, but in fractures of the clavicle and scapula, of which we have had several in the last few months. With all other devices, Sayre's adhesive plaster method, with the Mittendorpf triangle, with any other device that I know of, you have continual or repeated shiftings of position. It is difficult to maintain a position in which the patient has confidence to go about his work. This man left the hospital the next day and attended to his business and has done so ever since, wearing his cast. We do not leave them in the cast too long. I have taken off a number of casts in three weeks when the parts were well apposed.

We first cut off the part of the cast below the elbow, next the outer half from the elbow to the shoulder, then the body cast, leaving the arm support in the axilla and under side of the arm for five or six weeks. This gives a chance for early massage and passive movement. The arm is abducted and rotated outward in the reduction, and fixed in the cast in moderate abduction, with the hand in such position that it can serve such use as is possible with the arm fixed. The early use of the arm is important in restoring function.

It is very important in treating fractures that you get early motion and massage, and maintain function, instead of letting the member stiffen up by fixation.

This case illustrates a fracture of the humerus at the middle of the arm. (Plate XIV.) When we got the cast on there was found to be a little longitudinal displacement, a little slipping of the ends of the bone. With extension on, with the moleskin up to the point of fracture, we cut away the exterior of the cast half way around the arm from the shoulder to the wrist leaving a cuff of plaster there, and with padded fixation of the shoulder, by making extension we bring down the lower fragment as far as we need to do, and a pad of felt between the forearm and remaining anterior portion of the cast maintains the extension.

Case 4.—This patient was a young aviator who fell with his plane three hundred feet before he struck the ground. He sustained several severe injuries. His front teeth were knocked out; his left arm was broken at this point (indicating); his acetabulum was split; he had a Pott's fracture, and was bruised all over. He was in rather profound shock. This was the way he came into the hospital with this temporary splint on. (Plate XV.) He was put in the same cast as I have shown you, and we have end-to-end approximation with some angular displacement. (Plate XVI.)

In the next plate you will see I made an effort to correct this condition. (Plate XVII.) I made a circular cut three-quarters of the way around. We cut it on the concave side because if we cut on the convex side we would crowd the bone ends together. In other words, there would be a tendency to shorten it, but, if we cut it on the concave side, in bending it we did not shorten it any. There is a tendency towards elongation if the cast fits tightly. We do not do this correction until the swelling has subsided. One is an anteroposterior view, and this is a lateral. (Plate XVIII.)

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ACUTE HEMORRHAGIC PANCREATITIS; CYSTO-ADENOMA OF STENSON'S DUCT; TUBERCULOUS EPIDIDYMITIS; CALCULUS IN THE RIGHT URETER

SURGICAL CLINIC GIVEN AT THE WEST SUBURBAN HOSPITAL, OAK PARK

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I. ACUTE HEMORRHAGIC PANCREATITIS

Mrs. N. R., aged fifty-two, housewife, married.

Family History.—Patient was born in Sweden, and is the sixth in a family of thirteen children. A sister died at the age of six, and a brother at the age of eighteen, both of pneumonia. All the rest of the family reached maturity.

Previous History.—Married at twenty-five; one child now living; married a second time at thirty-eight, after having been a widow for ten years.

A laparotomy was done in Sweden nineteen years ago for some pelvic condition. Menstruation continued until the age of forty-three. Since coming to America, fourteen years ago, there have been recurring attacks characterized by epigastric pain, severe and colicky, of sudden onset and abrupt termination; vomiting with gaseous distention of the bowels; constipation has been the rule. Jaundice was never present; and the application of external heat together with rest in bed brought about prompt relief. Aside from habitual constipation, the patient states that she has been perfectly well between these attacks. The last attack occurred two years ago.

Her present illness began December 6, 1918, with sudden severe colicky epigastric pain. The pain was more severe than that attending any previous attack. There were vomiting and abdominal distention. Cathartics and enemas were tried but failed to force a bowel movement; and the measures which had afforded relief in former attacks did not help at all.

The patient entered the hospital December 7, 1918. The clinical picture, when I first saw her the day after her admission to the hospital, was as follows: A well-nourished and a well-preserved middle-aged woman, evidently suffering acutely from some grave abdominal condition. Her complaints of pain were constant and vociferous; the location of the pain appeared to be mostly umbilical and epigastric, although tenderness to pressure was more diffuse. There was uniform abdominal distention without audible or visible signs of peristalsis. Vomiting of a small amount of chocolate colored fluid, which was without odor, occurred at infrequent intervals. A white scar of a median laparotomy was present, extending from the umbilicus to the symphysis pubis. The temperature was 98°, and the pulse 140. Immediate operation was advised but not permitted until the following day. In the meantime, the patient's general condition had grown worse, her pulse being 150. The abdominal condition remained substantially the same. No flatus had been expelled, and no bowel movement had occurred.

Operation was done December 9, 1918. Having in mind an ileus, possibly in some connection with her former operation, I made a median incision through the old scar. Very extensive adhesions between the omentum and the parietal peritoneum were encountered. Several strong bands extended deeply into the pelvis. The descending and pelvic colon was empty and collapsed; the intestines elsewhere distended but nowhere discolored. A small amount of thin bloody fluid was found in the peritoneal cavity; this fluid closely resembled that commonly found in the sac of a strangulated hernia. A rather thick mass of omentum was adherent in the left pelvic region, which, on its liberation, showed numerous spots of yellow discoloration scattered over its free border. By this time the descending colon had become distended, and it occurred to me that perhaps I had relieved a possible intestinal obstruction; at any rate, the patient's condition would not permit any further exploration, her pulse having risen to 180. However, having at the last minute found strong evidence of pancreatic trouble in what I took to be areas of fat necrosis, after removing some of this tissue for examination, I hastily flushed the abdominal cavity with normal salt solution and closed the incision without any drain.

The next day the patient was still there, and although her pulse was 160, she said she felt better. She certainly complained less. The urine, which previously had been reported negative, two days after the operation showed a trace of sugar, and ten days later careful quantitative examination gave the sugar content as 4½ per cent. In the meantime, the pathologist (Doctor French) reported that the sample of fluid from the peritoneal cavity showed pancreatic ferments, and that the specimen of omental tissue contained typical areas of fat necrosis.

This conclusive, if somewhat belated, diagnosis of acute hemorrhagic pancreatitis with fat necrosis and subsequent glycosuria, found the patient improving daily, taking nourishment cautiously in small amounts; her stomach not tolerating much without distress, bowels moving, abdominal distention gone, except a fulness in the epigastrium which was characterized by marked tenderness on pressure.

By the end of one month every distressing condition, except the epigastric tumor, had disappeared. The urine was free from sugar; the temperature, having remained normal throughout the illness, was still normal. The pulse ranged from 100 to 120. The epigastric tumor was much more prominent, however, and was becoming more tender and painful.

With a certain diagnosis and a clear indication, a second operation was done January 9, 1919, just one month after the first one.

An incision over the epigastric tumor carried through the gastrohepatic omentum evacuated three pints of thin grayish sterile fluid. Careful retraction revealed a deeply-lying slate-gray, slippery-looking mass, which clung to the walls of the cavity but could be torn away without any hemorrhage. The mass extended from the midline towards the left as far as the spleen. After picking out with forceps all the necrotic tissue that could be thus removed without undue delay, a gauze drain was left in the cavity and the incision partially closed. The patient suffered but little shock from this operation, and the clinical course has been uneventful. At this time, fifteen days after her last operation, while the drainage opening has not entirely closed, the patient's general condition is fairly good.

The urine does not now contain sugar, and there is but little digestive disturbance. Her epigastric distress is all but gone, and she will leave the hospital in a few days.

This case of pancreatic disease illustrates a number of points well worth bearing in mind. The previous history, showing acute attacks of what in all probability was gall-stone colic, is suggestive. The violence and persistence of the symptoms should be noted. The resemblance to intestinal obstruction is, of course, characteristic of many attacks of pancreatitis, as it is likewise of the first hours of an acute gall-stone attack.

Whether the first operation, when only flushing of the abdominal cavity with normal salt solution was done, without subsequent drainage, did any real good cannot be certainly settled. I am inclined to think it helped to tide the patient through the acute stage. Leaving the belly full of normal salt solution seemed to me more logical than inserting a drain in the lower abdomen, and the patient's condition made it imperative that the operation be stopped.

The subsequent operation showed destruction of the body and tail of the pancreas with sequestration and without any evidence that the process had at any time been due to infection. The clinical record, the blood findings, and the encysted fluid, were all against any acute infectious process. A portion of the pancreas—the head—seems to have escaped and to have resumed its usual function.

In my seventeen years of continuous service as attending surgeon to the Cook County Hospital, I have had to deal with a number of cases of acute hemorrhagic pancreatitis; and the results of operation with drainage have not been flattering. However, I shall probably drain the next one. Overlooking the diagnosis in this case does not seem to me wholly excusable, yet it is just possible that the patient's safety was thereby conserved.

Note.—Examination of a specimen of urine on March 3, 1919, showed it to be sugar negative.

II. CYSTO-ADENOMA OF STENSON'S DUCT

Miss M. A., aged sixty-four, dressmaker by occupation, has had no serious previous illness. She has worn an upper plate with full set of teeth for the past twenty-five years. Her family history is negative.

Eighteen years ago a small abscess "like a boil" formed on the inner side of the right cheek well back and rather high up. There was a discharge of pus-like material and always thereafter this point projected somewhat into the mouth, although there was no further discharge of pus. The upper plate of teeth when in position pressed upon the site of this " boil " and a " lump " could always be felt there. Ten years ago this " lump " could be seen as a noticeable tumor in the cheek, and during the past year there has been an increase in size, while the cutaneous vessels over the most prominent parts have become conspicuous. The growth has always been painless except for one brief neuralgic attack, which lasted two days, in November, 1918.

The general examination revealed nothing of interest. The tumor, two inches in diameter, occupied the middle of the face on the right side just forward of the parotid gland, which gland was about three times its natural size. The two enlargements were almost continuous, only a slight depression appearing between them. Inside the mouth a red pedunculated body one-third as large as an ordinary thimble projected from the inside of the right cheek at the site of the mouth of Stenson's duct. A slight facial paralysis was evident, especially about the right eye. The skin over the most prominent part of the tumor showed signs of breaking down.

Having thus to deal with a tumor of the parotid region, which was showing signs of undue activity, operative treatment was advised and accepted. As the appearance of the tumor strongly suggested malignancy, a radical operation seemed indicated.

Ligation of the right external carotid immediately above the origin of the superior thyroid was done January 14, 1918; at the same time a little tissue was removed from the tumor for microscopic examination. It was noted that none of the cervical lymph-glands seemed involved.

The pathologist (Doctor French) reported a cysto-adenoma without any evidence of malignancy. Feeling encouraged, if not wholly convinced, by this favorable report, operation for removal was undertaken January 21, 1919.

An incision forward from the middle of the parotid with extensions upward and downward along the anterior border of the parotid portion of the tumor secured a good exposure. The anterior and older portion of the tumor was first attacked. It proved rather easy of removal, the substance appearing soft and pulpy, with a projection through the buccinator at the anterior margin of the masseter; in other words, following the normal direction of Stenson's duct. The dissection opened into the cavity of the mouth.

Turning now to the parotid portion of the tumor, dissection revealed that the growth was superimposed upon the parotid proper, which gland, although enlarged, was hard and fibrous and withal of quite different appearance.

It was quite evident that the parotid was not the real offender, and having by this time come to think better of the laboratory report, I decided to curb my ambition to remove the deeper parts of the parotid and thus paralyze the patient's face, and accordingly, after using the thermo-cautery rather freely on such areas as seemed to have been incompletely dissected away, I closed the incision.

This tumor was not a simple salivary cyst; it was largely glandular—a cysto-adenoma of Stenson's duct, doubtless induced by the long continued irritation of a dental plate through its pressure and obstruction to the outlet of the duct. It is doubtful if any function remains in the parotid gland of this side. A gland that is unable to deliver its product stops secreting.

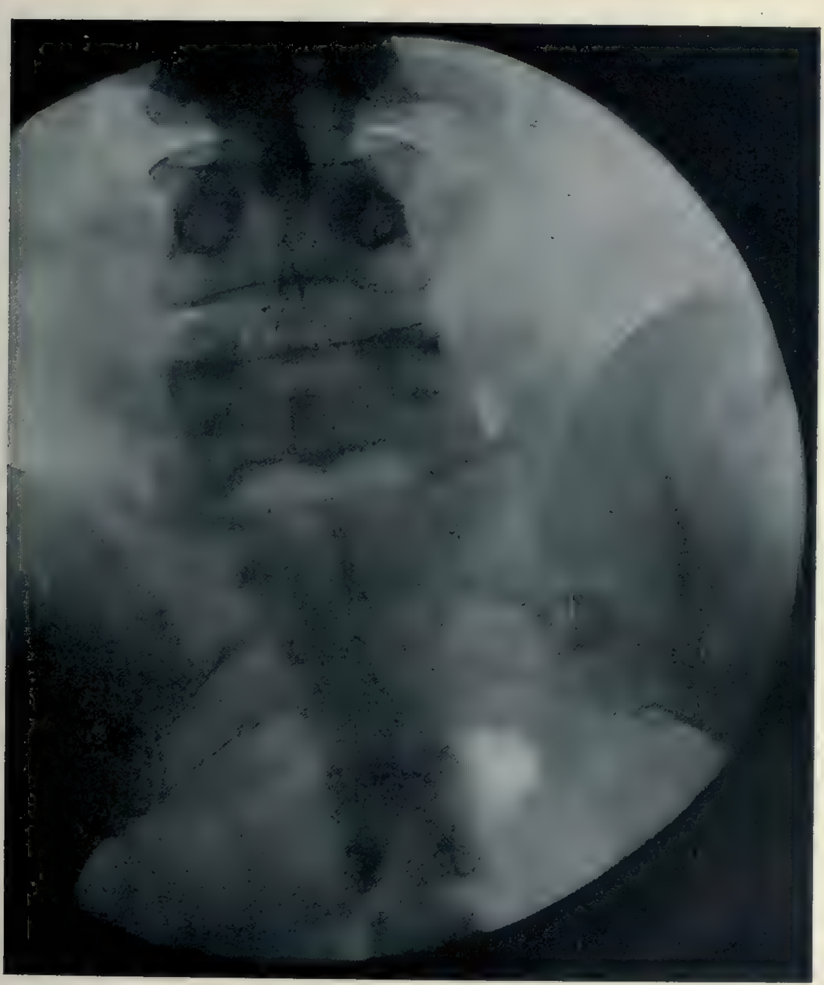
III. TUBERCULOUS EPIDIDYMITIS

Wm. G. H., aged thirty-six, occupation salesman, was operated on seven months ago for "trouble" in the right testicle. The condition was present for several months before this operation was done and was accompanied by a loss of weight with failure of the patient's general health. Venereal disease was denied. There is a recurrence, or persistence of the former trouble in the right side of the scrotum.

General examination is negative, except there is enlargement of the right epididymis, the globus major particularly, with nodular masses along the course of the spermatic cord near the external ring. Wassermann test is negative, as is also rectal examination.

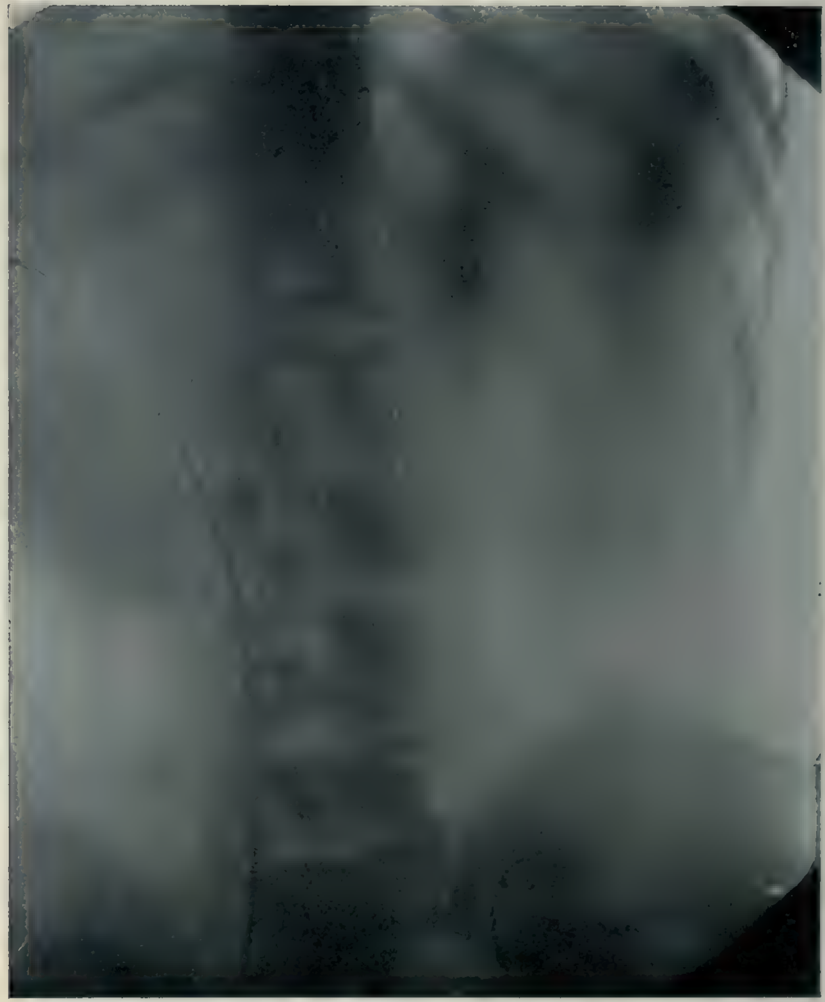
This patient exhibits a tuberculous lesion of the right epididymis and spermatic cord. The seminal vesicles appear to have escaped. The testicle proper, while slightly enlarged, has the appearance of being free from invasion. If there is a tuberculous lesion elsewhere in the body, it is very unobtrusive and inactive. However, I am not prepared to say that the lesion is primary in its present location. The case does seem a very favorable one for operation. The former operation was evidently an incision with prolonged drainage. The tuberculous process now shows both proximally and distally to the scar of the previous operation.

FIG. 1.



Shows the stone in the right side of the pelvis in the course of the ureter.

Fig. 2.



Shows the stone in its relation to the opaque catheter; likewise the direction the catheter has taken after passing the stone.

An incision through the scrotal tissues permits the testicle, epididymis and cord to be displayed for inspection. The testicle is not involved. The epididymis presents a typical condition of rather advanced tuberculosis. The cord is large, lumpy, and characterized by tubercular nodules all the way to the external ring, and following the vas deferens through the inguinal canal, its lumen is found plugged with caseous matter. Dividing the vas at the highest accessible point with the actual cautery, the epididymis and vas deferens are now completely excised, including all tuberculous material.

Removing the epididymis does not affect the nutrition of the testicle if ordinary care is taken to preserve its blood supply, which normally comes from three sources: (1) The spermatic artery, direct from the aorta; (2) the artery of the vas from the superior vesical, and (3) the cremasteric artery from the deep epigastric. The artery of the vas is in this case, of course, sacrificed, but this one can be easily spared. The testicle thus deprived of its duct will shrink somewhat, but whatever of internal secretion this organ has, will be retained; and the patient will be better pleased to know that he still has two testicles.

In this case, only time will tell whether further tuberculous mischief will be met with in the genital organs. There is a good chance that the patient's natural powers of resistance will complete the cure.

IV. CALCULUS IN THE RIGHT URETER

Mrs. M. F., aged twenty-four, married, was admitted to the West Suburban Hospital February 19, 1919.

Family History.—Mother died at forty of tuberculosis; father at thirty-two, accidental death.

Previous History.—When ten years of age the patient had urinary incontinence which has been present occasionally ever since. A laparotomy was performed in the County Hospital, Kansas City, Missouri, in the year 1910, by Dr. Jabez N. Jackson. Patient thinks the appendix was removed and something done with the right ureter. No drain was used. She was in the hospital from November until the following January. Her menstruation began at sixteen and has been normal. She was married in 1914; no pregnancy.

For the past three years the patient has had "stomach disturbance" with vomiting spells every four or six weeks. Lately the attacks have been more frequent and have been characterized by headache, dizziness and abdominal pain. Occasionally she is constipated, but not as a rule.

Her present illness began December 15, 1918, with severe pain in the right side of the abdomen and right loin during the menstrual period. After a few days there was a discharge of pus from the vagina which continued for a week or more. She was removed to St. Elizabeth's Hospital and remained there four weeks. She is said to have had peritonitis, fever, meteorism, pain, and constipation. She went home improved, but was very pale and weak, and had a new gastric attack.

The physical findings are those of a very pale, poorly nourished woman of apparently twenty-five years of age, with a hollow cough, impressing one on entering the room as a case of advanced pulmonary tuberculosis. Examination of the chest proves negative other than the findings that would naturally be present with a subacute bronchitis. The emaciation from the history is accounted for by the recent illness of the patient and represents a loss of weight from 119 to about 90 pounds. The condition of marked anæmia, which appears more severe than the blood count shows, has caused a delay in undertaking the operation which we are about to do.

The physical findings of the abdomen in this thin patient reveal a tender and irregular but not large mass in the right iliac region rather lower than the normal site of the appendix. This is corroborated by vaginal examination and likewise shown to be separate from the uterus. There is no discharge of pus from the vagina at present, and whatever the suppurative process was, it has quieted down until it is not in evidence to-day.

A laboratory examination made February 20 disclosed no tubercle bacilli in the sputum. A blood examination made on the same day showed red cells, 4,750,000; whites, 8400; hæmoglobin, 60 per cent.

X-ray examination made on February 21 failed to disclose any evidence of a calculus in either kidney. A shadow, about the size and shape of an olive, shows probably a calculus in the right ureter above its junction with the bladder. February 25 an X-ray was taken of the ureters with the opaque catheter in position. Examination of the urinary tract of the right side revealed a large stone, as previously reported, which had been dislodged and displaced slightly upwards. The catheter passed the stone and apparently became caught in the lateral wall of the ureter, which probably is much dilated, as the catheter was curved some distance to the right of the course of the normal ureter.

Clear normal urine issued from both ureters, showing both kidneys to be about equally active.

The position of the stone in the ureter is indicated by the X-ray, and is found by deep palpation to show tenderness; and it is at the inner border of this mass previously referred to.

The incision which I would make for a stone in the ureter under ordinary conditions is not one which I am about to make in this case. The pathology in the right lower abdominal and pelvic region somewhat obscures or complicates the conditions here, and I shall make an opening through the abdominal wall and into the peritoneal cavity to begin with.

The patient is now relaxed; a small amount of anæsthetic has been required. On opening the abdomen a little to the right of the midline, withdrawing the rectus muscle outward, the incision is carried through into the peritoneal cavity. Exploration reveals small intestine, the cæcum and the right ovary in a mass. The adhesions are so hard and fibrous in nature that this condition must have existed for a long time. The mass extends upward behind the cæcum, and it is evident that the extraperitoneal approach to the course of the ureter at the level of this stone is not feasible. A catheter has been passed into the right ureter, having been inserted by Doctor Poorman immediately before the beginning of the anæsthetic, and will be of assistance to us a little later. Under present conditions I feel that the safest approach will be through the posterior parietal peritoneum directly down upon this foreign body, and accordingly incise the peritoneum, the intestines being, as well as can be on account of adhesions, displaced upward with some of them to the right. I come down immediately upon a small hard retroperitoneal tumor and by gentle retraction I am able to incise directly upon it, going through where the tissues are thinnest and stretched over the tumor. The common iliac artery is just above this tumor, and the internal iliac is immediately to its side, so that extreme care must be exercised. Enlarging the buttonhole into the capsule of this stone which is now visible, I am able to extract it with forceps, but the stone breaks in being delivered. The catheter in the ureter seems not to pass through this sac where the stone lies; it seems to be behind and internally. I feel it but I cannot by careful retraction see the catheter.

I will now ask Doctor Poorman to withdraw the ureteral catheter until I feel its upper end pass to below the level of the site of the bed of this encysted stone. A tiny vessel in the edge of the incision into the bed of the calculus is causing a little hemorrhage, but it is easily controlled by a hæmostatic forceps and will be presently taken care of by including it in a suture.

As this case is not easily drained, and as there is plenty of slack for closure, I now proceed to close the incision into the pocket of the stone and make it watertight by three rows of sutures, using chromic catgut and closing the peritoneum over it. Giving attention to the mass below the cæcum and in the region of the ovary—the ileocæcal junction is free. The cæcum itself is held down by dense adhesions. On dissecting these up somewhat for a possible diseased appendix, there seems to be no appendix, it evidently having been removed at the former operation, or destroyed in the abscess which discharged for some weeks. This, however, is improbable, as the whole appendix is very seldom destroyed and discharged in any abscess about the appendix.

The urine discharging through the ureteral catheter, which was clear at the beginning of the operation, is now somewhat bloody. The catheter will now be withdrawn and the patient put to bed. One quart of water will at once be administered by rectum which will be retained. The lower bowel does not resent the introduction into it of large amounts of water while the patient is still under the influence of the anæsthetic.

The addition of sodium chlorid to the water is illogical and unnecessary and under certain kidney conditions may even be harmful. For a number of years I have followed the custom of giving tap water per rectum after laparotomies—a quart or more immediately following the close of the operation, with lesser amounts at frequent intervals. This treatment all but banishes postoperative thirst and in other respects is beneficial to the patient.

11

SPINAL ANESTHESIA IN GENERAL AND GENITO-URINARY SURGERY*

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AND
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As an introductory remark I would state that my personal experience with spinal analgesia dates back about 10 years, and embraces approximately 1,000 cases. Stovain at first, then novocain, and for the past 8 months apothesine have been employed. Death could be attributed to the anesthetic agent in only one of my cases.

Spinal analgesia is not a new field, but it is one in which much work is still to be done to determine its relative merits and its applicability to certain classes of cases in preference to general or local anesthesia. An American physician, J. L. Corning, was the first to experiment with spinal anesthesia and his findings were published in 1885 in the *New York Medical Journal.* He used 2 per cent. cocain solution and obtained anesthesia in both animals and man. He did no operations and did not even aim to inject the solution into the spinal canal, believing that if he introduced it into the nearby veins it would be carried into the cord, but he must have placed it in the canal, otherwise the effects he noted would not have been so rapid and complete. His work did not stimulate any further researches and was soon forgotten until Quincke's description of lumbar puncture in 1891 led to the rediscovery of spinal analgesia and Bier used it on himself and the procedure was soon established more or less universally. Cocain was used exclusively in the early cases but the mortality was so high that the method dropped into disuse with the exception of certain clinics where efforts to improve the solution, the technic and the selection of cases continued until it was finally again placed on a stable basis.

Following the discarding of cocain, stovain was introduced by Fourneau and Tuffier in 1904 and is still in use. It has a greater paralyzing action on the motor nerves than any other agent and hence provides good muscular relaxation, but is considered more dangerous for this reason if it reaches and affects the respiratory nerves or centers. Novocain has been used but it is not entirely satisfactory, while tropococain is the most popular at present and apothesine has only come into use during the past year or two.

The mechanics and physics of the action of the agent used depend upon certain features of the contents of the spinal canal and upon the curvatures of the bony framework. The cerebrospinal fluid has been supposed to move in and out of the canal, but while the pressure of the fluid certainly changes with position, it is doubtful how much of this is due to actual displacement of the fluid into the cranium from the spinal canal and vice versa.

If a fluid in introduced into the canal, of the same specific gravity as the spinal fluid, it will remain practically at the point of introduction, while a lighter fluid, if the patient is in the vertical position will ascend toward the head and a heavier one sink by gravity toward the lower end of the canal. If the patient is in the horizontal position the normal curves of the spine will influence the motion of the solution toward the head or the feet, depending upon the site of injection and the density of the solution. For example, the lumbar spine has a distinct anterior convexity and a heavy solution introduced at its most prominent point, about the interspace between the 3rd and 4th lumbar vertebrae, may gravitate either upward as far as the most posterior point of the dorsal convexity, approximately the 5th and 6th dorsal vertebrae, or downward into the sacral portion of the canal. If the patient is lying on one side or the other the heavier solution will accumulate along the dependent side as has also been dmonstrated clinically in cases where the right lower limb has been rendered anesthetic while the patient was lying on that side while the left lower retained both sensation and motion. Hence the anesthetic solution will generally remain en masse at that area of the canal it reaches as the result of gravitation and will act upon the nerve tissues in that locality. Some diffusion of the solution along the canal for a considerable distance upward must occur, however, judging from the frequent evidences of its action on the medullary centers even when the head and shoulders are kept considerably elevated. Since gravity so markedly influences the action of the anesthetic agent, solutions both lighter and heavier than the cerebrospinal fluid are used, depending upon the position the patient is to assume for the completion of the operation.

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*Read at the Sixty-ninth Annual Meeting of the Illinois State Medical Society at Peoria. May 21, 1919.

The physiologic action of the agent on the functions of the body depends on the drug used and on the strength of the solution. Shortly after injection the analgesia becomes manifest, first in the genitalia, perineum and inner sides of the thighs and then proceeds upward a variable distance and downward to the toes. The interval between the injection and the establishment of a sufficient degree of analgesia to permit of operation varies from 3 minutes to half an hour or longer. Anesthesia is seldom complete, pain sense being abolished, but tactile and muscular senses are often only impaired. Paresis or paralysis is present and the reflexes disappear. The blood pressure is generally markedly lowered and the heart action slowed and weakened while respiration may also be affected and symptoms of syncope or even collapse in certain cases may appear. Pallor, sweating, nausea and vomiting are not infrequent. The low blood pressure is due to paralysis of the vasomotor and intercostal nerves and the lowered heart action to the slow filling up of the heart, the flood being in the dilated internal vessels. The action on respiration is due partly to paralysis of the intercostal nerves, and partly to the lessened blood pressure interfering with the blood supply of the respiratory center. Peristalsis is markedly increased by spinal analgesia and distention of the intestine relieved, thus facilitating operative meneuvers in the abdomen. Death, when it occurs, is probably due to the action of the drug on the efferent vasomotor fibers supplying the splanchnic area which allows of an enormous collection of blood in the large venous trunks so that the patient is practically bled to death by this accumulation of blood in the large veins. Paralysis of the respiratory and bulbar vaso-motor centers may also be fatal. The use of oil and gum arabic as a solvent for the anesthetic agent to allow of slow diffusion has been tried but has not been very successful. Making the solution heavy by the use of glucose so as to prevent too much diffusion has been the most successful expedient.

The solution use by me during the past 8 months has been apothesine in distilled water in the proportion of 1 grain to 1 c.c. approximately a 6⅔ per cent. solution, which when further diluted with an equal amount of cerebrospinal fluid makes a solution of between 3 and 3½ per cent. From 2 to 3 grains of the drug are used, depending upon the patient and the nature and duration of the operation. This solution is considerably heavier than cerebrospinal fluid and gravitates readily in the canal. About 200 operations have been performed, with one death and two serious collapses with recovery. The list of operations performed includes amputations, varicose veins, neoplasms, arthrotomies, plastic operations, bunions, osteomyelites, bone plastics, and aneurysms done on the lower extremities, hernias, varicoceles, hydroceles, amputations of the penis and hypospadias, one of which cases required operating for 2 hours; hemorrhoids, fistulae in ano, plastic operations on the vagina and perineum, dilation and curettage, which are about the most favorable types of cases, as spinal analgesia gives complete relaxation and is free from the muscular spasm and straining so common with general anesthesia and the analgesia is easily obtained with low lumbar injections. Prostatic surgery is a favorable field, as Dr. Nagel will show, both on account of the us ually poor physical condition of the subjects and the ease with which anesthesia is successfully induced. In abdominal surgery the perfect relexation of the abdominal muscles and the absence of distention of the bowel make operative procedures easier and less manipulation of viscera necessary and post-operative gas pains are seldom severe or prolonged. Appendectomy, intestinal obstruction, and myomectomy have been successfully done several times, as well as gastro-enterostomy epiplopexy and operations on the bile passages. In intra-abdominal work pain is sometimes caused by traction on the viscera or mestentery and the use of gas for a few minutes has sometimes been necessary. Only one operation on the kidneys—a nephrectomy for tuberculosis, has been done and this was highly successful. The patient was a woman past 50 years of age, who was considered a poor risk for ether. One Caesaraen section was done for eclampsia.

Failure to obtain anesthesia after apparently successful injection occurs occasionally, in 9 per cent. of cases, according to Allen. There may be incomplete or unilateral analgesia, or it may be of too short duration or may be delayed. The causes of the failure may be explained by idosyncrasy, or by errors in technic or possibly by getting an admixture of blood in the spinal fluid.

The indications for the employment of the spinal analgesia may be stated as including all cases in which the lesion is below the diaphragm and in which the use of general anesthesia is contraindicated, such as the aged and debilitated, those with cardiac, vascular and kidney lesions, asthma, emphysema, chronic bronchitis and tuberculosis, diabetes, alcoholics, patients in shock not due to hemorrhage, as for example in crushing injuries of the lower limbs, and strangulated hernias.

Contra-indications are the presence of severe shock and hemorrhage where the blood pressure is already too low and cases where respiration may be too much embarrassed, e. q. marked emphysema, hydro- and pneumothorax, and empyema.

The dangers from the use of spinal analgesia are mainly the results of lowered blood pressure and the consequent effects on the bulbar centers, especially that of respiration. When the dose is injected into the canal it is irretrievable and its action cannot be controlled by withdrawal or by elimination. Lowering the head in order to direct more blood to the brain is not practicable because this allows the solution to gravitate toward the medulla and to further disturb the centers, while sitting the patient up to keep the solution away from the cranium may induce severe or fatal syncope, so that when the dose is too large or idiosyncrasy present a fatal ending is more immediate than with general anesthesia. The only solution is in the determination of the proper dose and the control of its diffusion by correct position before and after injection.

The mortality in my hands has been one in 1000. This case was that of a man past 50 years of age who was septic for several months from a chronic cystitis and pyelitis, and who had an enlarged prostate with 2 vesical calculi, a large inguinal hernia and an immense post operative hernia into which the bladder projected, and a well-marked myocarditis. He was given 3 grains of apothesine in a 4 per cent. solution and very quickly went into collapse and died in 25 minutes, apparently from respiratory paralysis.

Various authors give the mortality as varying from 1 to 200 to 1 to 1,800, which is considerably higher than is usally ascribed to ether. However, there can be no question that there are numerous cases unusited to general anesthesia and in which the fatal outcome is attributed to shock after ether that could be successfully done under spinal analgesia. In comparison with ether the after effects of spinal analgesia are scarcely worth mentioning. Patients who have had both will invariably vote for spinal injection. Headache, nausea, vomiting, vertigo and syncope occur only occasionally and are of short duration. Pain in the legs and back are not frequent nor prolonged. Albumin has been noted at times. Incontinence and retention of urine are rather frequent, especially the latter, and the catheter has to be resorted to quite often and sometimes for several days or even two weeks in one of my cases.

Nervous symptoms and ocular palsies have been described as sequelae, but I have never seen either. Autopsies have not revealed any marked changes in nerve tissue except in experimental cases where lethal doses were employed.

Compared with local anesthesia by infiltration and nerve blocking, spinal anesthesia is undoubtedly more dangerous, but it is much simpler of application, more certain in its effects, incurs less patience and mental effort on the part of both patient and operator, requires a much shorter time and less discomfort on the table, does not obscure the anatomy of the parts and is followed by much less pain and suffering.

Several years ago I began the use of local anesthetics in my genito-urinary work, mainly because a large amount of work of a surgical nature had to be done upon patients who were bad surgical risks. My work was directed more particularly along this line to the removal of the hypertrophied prostate gland. These cases are always poor surgical risks, and under a general anesthetic the mortality rate was high, the patient passing away at the end of the third or fourth day from a hypostatic pneumonia, or a combination of pneumonia and uremia. I used in these cases the prasacral infiltration with results that were highly gratifying, as the mortality rate dropped to a very low percentage, proving conclusively that the general anesthetic had much to do with the previous high death rate, as my technique was the same and the class of patients operated upon did not vary. In age they ran from 63 to 82 years. The anesthetic in all these cases was novocain or apothesine. Several months ago in conjunction with Dr. George F. Thompson we began the use of spinal anesthetic with apothesine. I wish to merely record my experiences in the genito-urinary cases. A total of fourteen patients received spinal anesthesia with one death. Ten of these were prostatics and for carcinomas or carcinoma papillomas of the bladder. In all of the prostatics the final step of the operation under spinal anesthesia was not undertaken until at least one week after a suprapubic cystotomy had been done under local anesthesia, using the infiltration method except in one case. This patient was in very good condition, and a complete operation was done under spinal anesthesia. The one death which is here recorded was an individual who in every sense of the word was a poor surgical risk. The second step was undertaken ten days after the primary cystotomy and he succumbed one-half hour after the operation had been completed. This patient had long been a sufferer from prostatic obstruction, and was very much emaciated and septic.

In all these cases the anesthesia was complete and ideal from the standpoint of the patient and operator. G. G. Smith, in the Year Book of Anesthesia, states that 5 to 10 per cent of spinal anesthesias are not complete, part of which, however, he believes is due to faulty technique. Excepting the death as previously noted, no bad results in the other cases were observed. The pulse rate and respiration did not vary materially. It has been noted that in spinal anesthesia there is always a fall in blood pressure, and the death here recorded, I believe, was due to this cause, the falling being too great a strain for a heart that was already struggling under changes in the heart muscle due to a myocarditis of long standing. In this case I believe the parasacral infiltration would have had a greater percentage of safety for the patient. I believe that spinal anesthesia can be used or rather should be limited to the younger prostatic and individuals of advanced years with other bladder pathology, but whose circulatory apparatus has not undergone marked degenerative changes. The operator who is called upon to do genito-urinary surgery upon patients past the age of fifty-five years will find no one method of anesthesia ideal and suited to all cases. I have quite definitely abandoned general anesthesia in these cases, except possibly in an occasional selected case. In parasacral infiltration and spinal anesthesia I believe I have two methods that will give these patients the greatest degree of safety, using the spinal in the younger division and the parasacral in those cases of marked degenerative changes in the circulatory system.

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EARLY DIAGNOSIS OF ACUTE ILEUS

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CHICAGO

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Early Diagnosis of Acute Ileus

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While the diagnosis of ileus due to strangulated hernia is usually made almost at a glance, there are frequently well developed cases of ileus from bands and kinks, intussusception, volvulus and mesenteric thrombosis which are not easy to recognize in their early stages. The classic signs of abdominal pain, nausea and vomiting, tympany and stoppage of the bowels are frequently lacking, and the medical attendant must make an early decision whether or not laparotomy should be performed.

There frequently is no pathogonomic sign to aid in the diagnosis, and this is especially true of that form of adynamic ileus due to mesenteric thrombosis. In this condition, abdominal distention is the only sign during the early stages. The patient did not complain of pain, because of the absence of the violent peristaltic assaults on the obstructing element, so strikingly demonstrated when the muscular waves are suddenly arrested at the site of a strangulated hernia or intussusception. The whole bowel included in the thrombosed arc is in a state of flaccid paralysis, and is incapable of peristalsis. Distention of the bowel results from the loss of tonus in the intestinal muscles and from the gases generated by the putrefaction of the intestinal contents consequent to the stasis. As time goes on, and the element of peritonitis is added, the condition becomes an abdominal crisis, and there is no hesitancy in advising immediate laparotomy. It is necessary, therefore, to reach an early decision as to operation before the pathologic changes become so developed that a diagnosis is rather forced on the physician than reached as the result of an early appreciation of the morbid sequence. Unlike adynamic ileus, the obstruction resulting from a mechanical obstruction to peristalsis and to the onward passage of the intestinal contents, in the vast majority of cases manifests itself by symptoms corresponding in intensity to the degree of obstruction. The rule is, that in those cases in which the stoppage is instantaneous and complete, the patient suffers violent abdominal pain followed by reflex nausea and vomiting. Abdominal distention follows in a few hours, and in many instances peristaltic waves may be observed, beginning on the left side of the abdomen and coursing toward the right, becoming arrested at the point of obstruction. This sign in itself is pathognomonic.

ILLUSTRATIVE CASES

The following cases illustrate the difficulties of diagnosis in the early stages of these two types of obstruction and the necessity of early operation:

Case 1.—*Mechanical ileus with gangrene of 30 inches of the bowel.*—Lieutenant H., admitted to the Medical Service of Major J. N. Hall, Camp Logan, Houston, Texas, had been operated on about one year previously for suppurative appendicitis, requiring drainage. The laparotomy wound healed by granulation, leaving a long, ragged scar. There was no postoperative hernia, and the patient had not complained of constipation or of abdominal pain subsequent to his operation.

Dec. 21, 1918, he complained of a moderate degree of abdominal pain, but this was not associated with nausea or vomiting, or abdominal distention; however, attempts to move the bowels were unavailing. The patient was removed to the hospital, and an examination at that time detected very little in the way of physical findings, although there was a moderate amount of rigidity in the lower part of the abdomen. There was almost no tenderness, and the pulse and the temperature were normal. It was, therefore, decided on account of the patient's good condition to watch developments until morning. At that time there was marked rigidity and tenderness over the lower abdomen, and no evacuation of the bowels had taken place. Immediate laparotomy was therefore advised and the patient given a general anesthetic.

The old irregular scar was first excised and the peritoneal cavity opened near the middle line in order to avoid, so far as possible, adhesions of the viscera to the under surface of the old scar. When the peritoneum was opened, a large amount of bloody serum drained out. The remainder was mopped up with sponges, revealing a dark mass which at first resembled a large blood clot, but which on being delivered through the wound proved to be a coil of gangrenous ileum. There was a marked putrefactive odor emanating from the wound caused by necrosis of the ileum, resulting from the strangulation of an arc of intestine by a band of strong fibrous adhesions. This segment of bowel measured 30 inches in length and had reached an advanced stage of decomposition. There were areas of grayish pultaceous tissue which were extremely friable; the remainder of the gangrenous loop was black and the vessels thrombosed. A moderate degree of septic peritonitis had been set up by the contamination of the peritoneal surface by the pathogenic flora of the intestinal contents and by the saprophytic organisms of putrefaction. This was evidenced by the blistered appearance of the peritoneum. No cultures of the exudate were made.

Intestinal resection by the suture method was done. The gangrenous arc of intestine, together with a generous strip of sound tissue on each side of the necrotic area, was isolated between intestinal clamps and resected, including the accompanying mesentery. Before removal of the segment of mesentery, it was carefully inspected to make certain that the stumps of bowel to be reunited would be assured of an adequate blood supply.

The anastomosis was made with two rows of silk suture. The method of Connell was employed for the first row and a second supporting line of interrupted sutures for the second stitch. In order to make the union as secure as possible, a piece of omentum of suitable size was amputated, and was sutured around the anastomosis in such a manner as to encircle the bowel at the point of contact of the divided ends. The intestine was then dropped back into the abdomen and the repair of the abdominal wall begun. On account of the large amount of connective tissue incident to the old suppurating wound, it was necessary to dissect out a large amount of scar tissue and to undercut laterally for a considerable distance to obtain normal tissue for the introduction of sutures. Closure was done in layers, leaving room for the introduction of two large rubber drainage tubes, one of which reached down to the lowermost part of the pelvis while the other reached down to the anastomosis. A pint of physiologic sodium chlorid solution was given intravenously while the patient was still on the operating table.

The after-treatment consisted of maintaining the Fowler position, the administration of the continuous drip saline, and morphin to allay peristalsis and pain.

On the third day a low enema was given for the relief of gas pains, and as often as necessary thereafter There was no postoperative nausea and vomiting, and the patient took orange juice and water by mouth on the third day.

This patient developed a small fecal fistula, which healed slowly without any further operative procedures.

Comment.—The mechanical ileus that developed in this case was directly chargeable to the old adhesions that had developed at the site of the former infection.. No attempt had been made to roll out the cut edges of the peritoneum, which frequently cement themselves to the underlying viscera and omentum, even in those cases in which no infection occurs. It is, therefore, the duty of the operator to safeguard his patient so far as possible from the danger of postoperative adhesions, by not permitting the cut edge of the peritoneum to be infolded. This can be easily accomplished by always bringing the needle out on the endothelial surface of the peritoneum.

Case 2.—*Thrombosis of the mesenteric veins, with gangrene of 42 inches of bowel.*—Sergeant H., admitted to the medical service of Major J. N. Hall, Camp Logan, Houston, Texas, Dec. 16, 1918, had felt in his usual good health and had gone to town on a pass. He ate a large amount of peanuts in addition to a hearty meal, and the next morning complained of not feeling well and would eat no breakfast. A few hours later he was seized with acute abdominal pain, nausea and vomiting, and tenderness over the whole abdomen. Attempts to move the bowels by cathartics and enemas were unavailing, and tympany became marked. There was no elevation of the pulse or the temperature, and the physical examination of the chest was negative. The abdomen resembled that of a man suffering from retention of urine, as there was a tumor occupying the lower portion of the abdomen corresponding in size and shape to the overdistended bladder. The patient stated, however, that he had no difficulty in voiding urine; but, in order to confirm this, the bladder was catheterized and only a few drops of urine were recovered. It was thought possible that there might be an abscess of the abdominal wall with a resulting reflex ileus. Immediate operation was advised because, while it was impossible to make an accurate anatomic diagnosis on the basis of the underlying pathologic condition, it was impossible to escape the conviction that the man was suffering from ileus, either of the mechanical, dynamic or adynamic type. The tumor assumed the shape and size of the mass sometimes observed in the condition described under the term "ileus duplex," in which several coils of ileum are pasted together and lie with the ruptured appendix in the true pelvis.

This tumor, if appearing in a woman, would almost surely result in the diagnosis of uterine fibroid, before the bimanual examination was made.

Under general ether anesthesia a right rectus incision was made in order to give the most liberal exposure of the abdominal contents. The possibility of an abscess of the abdominal wall was kept in mind while going through the tissues, but no collection of pus was found. When the peritoneal cavity was opened, a considerable amount of bloody serum was found. There was an odor of putrefaction which was explained by the exposure of a large amount of gangrenous bowel. This was carefully lifted out until normal intestine was met, both proximally and distally. The gangrenous arc constituted 42 inches of the ileum and was consequent on a thrombosis of the mesenteric veins draining that segment. No other pathologic condition was noted to account for the mesenteric thrombosis.

It was considered doubtful whether operation was warranted because of the great amount of tissue involved, but on account of the patient's good general condition, it was felt that resection was justified.

The gangrenous arc was isolated with the intestinal clamps applied well into healthy tissue, and an end-to-end anastomosis was made by the suture method. Two large drainage tubes of rubber were inserted, one down to the site of the anastomosis, and the other down to the most dependent portion of the pelvis. One pint of physiologic sodium chlorid solution was given intravenously during the course of the operation, and the patient was returned to bed with a good pulse.

He was immedately placed in the Fowler position on the Gatch frame, and hypodermoclysis was begun with physiologic sodium chlorid solution by the drip method. The patient experienced no postoperative nausea nor vomiting, and there was but little abdominal distress. The bowels moved on the second day with the aid of an enema, and thereafter once or twice daily until convalescence was well established. There was a considerable amount of drainage of serum through the tubes, the first of which was removed on the fourth day, and the second on the eighth day. The rectal salines were discontinued on the fifth day, but the Fowler position was maintained for ten days. The highest point reached by the temperature was 100, and by the pulse, 120.

The abdominal wound healed by primary intention, except at the point at which the tubes were introduced; this healed by granulation, but there was no tendency to hernia. The patient returned to duty, Jan. 24, 1919.

Comment.—This case emphasizes the vast importance of making an early diagnosis of pathologic changes within the abdomen requiring immediate operation, and subjecting the patient to operation without delay, even though the precise anatomic and pathologic lesion cannot be recognized before entering the peritoneal cavity.

Appendicitis at Camp Logan as a Sequel to Influenza and Pneumonia

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FIVE HUNDRED AND THIRTY-FIVE NORTH DEARBORN STREET
CHICAGO

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APPENDICITIS AT CAMP LOGAN AS A SEQUEL TO INFLUENZA AND PNEUMONIA

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It is well known that the occurrence of several cases of acute appendicitis in rapid succession in a small community, typically in a boarding school or similar institution, is commonly in association with an epidemic affecting the respiratory tract. Most commonly we find streptococcic sore throat as the precedent disease, but not infrequently an epidemic of severe colds. Several such outbreaks have come under our observation. The studies of Rosenow are of special interest in this connection.

The increased number of cases of acute appendicitis requiring operation at Camp Logan since the recent respiratory epidemic has therefore attracted our attention. It is only fair to say at the start that the management of the medical service has been in the same hands since the opening of the hospital. The two chiefs of surgery, Major J. H. Blackburn and Major F. G. Dyas, have worked in closest cooperation with the chief of medicine, always under the general and close supervision of the commanding officer, Lieut.-Col. J. M. Willis, M. C. Thus absolute assurance may be given that the type of case recommended for operation has not varied during the entire period.

As showing the character of the epidemic, we may state that the admissions for influenza from Sept. 13 to Dec. 1, 1918, when it had ceased, numbered 4,126, and for pneumonia and bronchopneumonia 531 and thirty-six, respectively.

A careful estimate of the average number of men in camp from Sept. 15, 1917, the date of opening of the hospital, until Sept. 13, 1918, the date of the influenza outbreak, is 24,000, although the maximum number had reached 36,600. If we compute the average incidence of acute appendicitis requiring operation for the year, from Sept. 15, 1917, to Sept. 13, 1918, we find it to be 10.4 per thousand per year. The total number of cases in which operation was performed was 250, as given us by Lieut. F. H. Crail of the department of surgery.

During the period from Sept. 13, 1918, to Dec. 31, 1918, ninety-two patients were operated on, the average incidence per thousand per year being 30.66. The great reduction in the number of troops in camp meanwhile should be noted, the average being only 10,000 men. From September 13 to September 30 there were fifteen cases; in October, three cases; in November, thirty-nine cases, and in December, thirty-five cases. The falling off in October is wholly inexplicable, as the epidemic was at its height. The seventy-four cases for November and December would present a rate of 44.4 per thousand per year. No case demanded operation during the first seven days of January, 1919, and only two in the first twelve days. It is to be observed that the great number of operations came after the epidemic had passed the high point late in October, and the December quota, thirty-five cases, came after the epidemic had disappeared. We have collated the number of cases coming to operation with reference to previous attacks of appendicitis and to the occurrence of either influenza or pneumonia.

In the ninety-two cases, twenty-five patients had had previous well defined attacks of appendicitis; twenty had had influenza during the present epidemic, and four had had pneumonia. We might well consider the latter under the influenza heading, as presumably every patient with pneumonia in this epidemic had influenza first; five had had a "bad cold" during the epidemic—presumably mild influenza. Thus twenty-nine of the ninety-two patients had had influenza, pneumonia or a notably bad cold since Sept. 13, 1918. This number would not at all account for the great increase in the number of cases of operative appendicitis, and they constitute almost a trivial percentage of the total number affected by the epidemic.

An interesting feature of the respiratory epidemic was the great number of cases admitted to the hospital with the diagnosis of acute appendicitis in which, after a few hours' observation, we changed the diagnosis to either influenza or pneumonia, and in which the further course confirmed our opinion that no notable disease existed in the abdomen. In the influenza cases we assume that the symptoms leading to a diagnosis of appendicitis arose from the participation in the acute infectious process of the lymphoid tissues of the appendix, as is often noted in tonsillitis, measles and similar acute diseases.

In pneumonia the pain and rigidity were, at times, apparently of the same type, but were frequently due to the reflection into the abdomen of the pain of the diaphragmatic pleural involvement accompanying a pneumonia of the right lower lobe. It should be definitely understood that no such cases were even seriously considered for operation, although about fifty patients were received whose provisional diagnosis was wrongly given as appendicitis.

Of the ninety-two patients operated on the diagnosis of the pathologist was acute catarrhal appendicitis in fifty-four cases; acute suppurative appendicitis in fifteen and chronic catarrhal appendicitis with subacute exacerbation in twenty-three cases. The chief of surgery, Major F. G. Dyas, was the operator in twenty-nine of the cases; Lieut. F. H. Crail in fourteen; Capt. Arthur Love in twelve; Capt. E. R. Dumke in eleven, and others in a few scattered cases.

The findings that led us to recommend operation were identical with those on which we have depended in civil life in the absence of epidemic disease. There were generally noted abdominal pain, vomiting, moderate elevation of temperature and pulse rate, tenderness and rigidity in the lower right quadrant, and an increase in the white count, commonly with a relative polymorphonuclear increase. The blood findings were of more than usual value in view of the normal leukopenia of influenza. Due weight was, of course, given to the history of previous attacks.

Every case was examined with special care as to the presence of pneumonia or other acute respiratory disease, and the routine examination of urine was made. In no case in which we operated did we fail to find a pathologic justification for the operation according to the best judgment of the pathologist, the surgeon and the representative of the medical department. We have several times observed in former years, as many physicians have reported, a full fledged acute lobar pneumonia, generally in the right lower lobe, in cases in which we were told that the appendix removed the day before had been practically normal. We had no such occurrence in this series. It is necessary to mention this specifically, since the possibility of such error would almost certainly occur to many clinicians. No patient with acute respiratory symptoms was subjected to operation even though there might be present tenderness and rigidity in the abdomen, without several days of observation, and only three cases were sent to the operating room until after the subsidence of all such symptoms.

Our laboratory report is incomplete, since, during the epidemic, the typing of pneumococci and the hemolytic streptococcus work could not wait. Major M. C. Stone, M. C., chief of the laboratory service, reports that in the cultures from the nonsuppurative appendixes the hemolytic streptococcus was occasionally found, but most of the cultures were sterile. The suppurative cases showed the pneumococcus, the colon bacillus and the streptococcus, but without evidence of any predominating type of infection. We greatly regret that the exigencies of the epidemic prevented a full study of the relationship between the respiratory infection and that of the appendix.

There is certainly no ground in our findings for closely connecting the attacks of appendicitis, in any direct bacteriologic way, with the epidemic, as one may connect empyema with definite types of pneumonia.

A satisfactory recovery occurred in every case but one. The fatal result was noted in a patient who had been five weeks in the cardiac ward early in 1918 with widely dilated heart and systolic murmur at the apex. His compensation remained so poor that he had been excused from even the morning exercises, which, when taken, exhausted him for the day. The appendix was a long retrocecal one, largely subperitoneal and acutely inflamed, but not such as to lead us to have any special anxiety as to the outcome. Exhausting suppuration occurred, and he died at the end of the first week.

The data that we present are insufficient to justify any exact conclusions as to the influence of the epidemic on the morbidity from appendicitis. Nevertheless, we believe there is firm basis for the opinion that some close relationship exists between the two affections. It is extremely suggestive that on the first day of the influenza attack so many patients showed such definite signs in the region of the appendix as to lead to a diagnosis that proved to be incorrect, assuming our opinion on this point to have been well founded. If this symptomatology was dependent, as we believe, on involvement of the lymphoid tissues of the appendix, we may readily conceive that in many other instances a definite inflammation resulted which eventually demanded operation.

Perhaps we are not far wrong in assuming that the epidemic, characterized as it was by a phenomenal activity on the part of many different pathogenic organisms, gave special opportunity for the development of inflammation of the appendix; but whether by reduction of the general bodily resistance, by exciting a new attack in a chronically affected organ, by its action on the lymphoid tissues, or by an infection through the blood stream or otherwise, does not appear. Certainly some cause lay behind the increase from a percentage of 10.4 for our first year, to a rate of 44.4 for November and December, 1918, in the incidence of appendicitis requiring operation.

We wish rather to place these observations on record as a minute part of the history of the great epidemic than to attempt to draw any extensive inferences from such slender data.

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IRRITATION OF THE DURA

Or Inner Periosteum of the Skull[1]

By CASSIUS C. ROGERS, AM., M.D., F.A.C.S., Chicago

THE human body is divided into three great cavities: the abdominal, lined by its parietal and visceral peritoneum; the thoracic with its parietal and visceral pleura; the third, and one that interests us, the cranial with its dura and arachnoid. Anatomically the dura will be considered under two heads, the outer layer or true periosteum of the inner skull, and the inner layer or, as it may be properly called, parietal layer of the subdural space. Therefore we find the three cavities with similar linings.

The normal contents of the cranial cavity are all-important to life and paramount to man's duties and relations to society. To arrive at an intelligent prognosis it is important that the etiology of the intracranial lesions and the extent of the damage done be ascertained. The means of obtaining a comprehensive knowledge of the extent of the lesion and the assistance one can give to nature to restore these structures to a normal function is our object. It is my intention to limit my remarks to the periosteum commonly called the dura and the symptoms which the patient may manifest from irritation to this structure.

The cranial cavity normally contains just sufficient structures to fill it, and the slightest variation therefrom will produce symptoms.

The periosteum lining the inner skull is identical to and contiguous with the outer periosteum of the skull at all the foramina so that the skull is covered on its intracranial surface over its entire bony area, as there are no attachments of muscles or ligaments to the inner skull as we have on the outer surface. We are then to deal with the true periosteum and all the pathological conditions and complications to which the periosteum may be affected in any other part of the body.

The greatest part of the brain is not sensitive to pain and can be manipulated and explored while the patient is awake and conscious without producing discomfort. This is not true with the dura or periosteum. The rich nerve supply of the dura, the trochlear, ophthalmic, semilunar ganglion, vagus, hypoglossal and sympathetic nerves render it one of most sensitive structures in the body, and the slightest irritation produces agonizing pain. Its rich blood supply, the anterior meningeal from the ethmoid branch of the ophthalmic; the middle meningeal, viz., the great and small middle meningeal from the internal maxillary, the meningeal branch of the lachrymal and of the internal carotid and the meningeal branch of the ascending pharyngeal; the posterior meningeal, which arises from the ascending pharyngeal, the occipital and the vertebral, all are distributed to the dura or periosteum over the posterior cranial fossa (Santee.) This great volume of blood going to the dura or periosteum is sluggishly returned by way of the venous sinuses, making the dura or periosteum an easy prey for toxines that are carried in the blood stream. Again, by its proximity to the accessory sinuses it is readily inflamed or irritated when these sinuses become the seat of disease. The irritation of the dura or periosteum may be considered mechanical or infective, and these under the subheadings acute and chronic.

Under the acute would be considered depressed fractures with loose spiculæ of bone and foreign bodies, such as pieces of steel, bullets, etc. As these are readily diagnosed and the surgical interference is universally recognized, we will spend no time in considering them.

The chronic conditions, however, are well worth our consideration, as it is these that are frequently overlooked. The most frequent of these in my experience has been the deposit of lime salts in organized extradural or, strictly speaking, subperiosteal blood clots. After the acute hæmorrhagic condition subsides the patient may be apparently well for weeks, months, or even years before any localized symptoms manifest themselves. The symptoms are pathognomonic and should be easily recognized. There is usually a history of a previous injury which may have been considered trivial by the patient at the time, and has long been forgotten until headaches appear, always localized in a definite area on the skull. The headaches may be constant, but more frequently are paroxysmal. They are exaggerated by bodily and mental fatigue, and are more frequent at night. They are agonizing, of gnawing, tearing character, and often associated with dizziness and vomiting. The pulse, temperature, and respirations may be normal and the blood count negative. During the attacks the cerebration is slow. The severity of the attacks may be epileptoid in character, and the patient may be mentally irresponsible for his acts and deeds. It is not infrequent for these patients to become heavy drinkers, using profane and most vile language during the seizures. They become adept liars and may resort to petty thievery. As the attacks become more and more frequent and severe, it is not at all unusual to find these cases declared insane and sent to sanitariums for treatment. It is true they act insane, but it is a pseudo-insanity due to a constant irritation and not to an actual brain lesion, as the insanity disappears after the removal of the irritant and the patient again becomes normal mentally in his acts and habits.

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[1] Read before the Chicago Surgical Society, February 6, 1919.

I will now cite the history of the first case of this kind upon whom I operated in 1907, or eleven-and -one-half years ago.

Mr. B., age 31, a laborer, married, father of two healthy children; family history negative. Several years previous to his illness he received an injury to the head which was considered slight. A physician was not called. Some years following the injury, while working for the Chicago Telephone Company and traveling from one side of the city to the other by means of a bicycle, he would complain of headache in the right frontal region, severe and localized to the size of a silver quarter. As the pain became more and more severe he would have lapse of memory, failing to return home after work, and while he was a temperate man at normal times he would frequently be found in saloons. He was once found in Iowa and had no recollection of how he got from Chicago. Another time he was found in Washington Park with his bicycle wrecked and he himself curled up under some bushes. He had no recollection of going from his home to Washington Park. He became unruly and vicious during the attacks. In 1907 he was trephined over the area of the previous injury, the area of the localized pain. When a bone plate two inches in diameter was removed the dura, or periosteum, was found to be covered for an area of one inch in diameter with lime salts giving the periosteum much the appearance and roughness of sandpaper. The bone was not replaced, the dura or periosteum not opened; the skin was sutured without drainage and the wound healed by primary union. The patient has not had an attack of pain or lapse of memory, he has not become intoxicated, since the operation and has held a responsible position ever since.

The report of a case similar to this, with an almost identical history and upon whom I operated in 1917, is given below.

Mr. P., age 35, American; family history negative. At the age of sixteen he fell from a building, striking his head upon a rock, which rendered him unconscious for about an hour. He managed to get up and go home. He was away from school for three days and was apparently slightly injured, and nothing more was thought of it for nine years, when he commenced to have dizzy spells, became nervous and irritable, with almost constant localized headache. He gradually grew worse during the next seven years, until 1915, when his headaches became so severe that the pain was unbearable. He became careless in his habits, neglected his business and his home and became a heavy and habitual drinker. In the summer of 1916 he became so unruly that he was sent to a sanitarium. In March, 1917, he was brought to the University Hospital. By the aid of stereoroentgenograms a depressed inner plate of the skull was easily demonstrable, with what was thought at the time to be a loose spicula of bone, but at the operation this was found to be a calcified subperiosteal blood clot; that is, the dura had the appearance and roughness of sandpaper. A plate of bone three inches in diameter that had been removed was not replaced. The entire area is now covered with bone, demonstrating the ossification function of the so-called dura, or a true periosteum. This man has not had a headache, has not drunk a drop, has not had a lapse of memory nor a "brain storm," since the operation, and is working every day.

I cite these two cases from a series of similar cases that I have operated upon, in all of which the results have been equally as satisfactory. There has been no operative mortality.

The second class of cases I wish to present comprises the acute, subperiosteal infections following infections of the accessory sinuses. The symptoms are so similar from all of the sinuses that we can classify them together. First, there is a history of a sinus infection.

As soon as the dura or periosteum becomes irritated there are characteristic symptoms that should tell one at once that the infection has gone beyond the sinus. The pain is increased and is exaggerated upon external pressure. The discharge from the sinus frequently becomes less. Often where there has been a temperature of 102 or 103° F., as soon as the dura or periosteum becomes irritated the temperature becomes normal or subnormal. From the irritation produced by the infection the dura or periosteum becomes œdematous, which causes intracranial pressure. I have previously stated that the cranial cavity is large enough to hold its normal contents only, and the slightest addition manifests itself by definite signs and symptoms. The pulse and respirations become slow and the blood pressure rises in direct ratio to the increased intracranial pressure. There may be a pathological leucocytosis, or the blood examination may be negative. There is projectile vomiting, usually associated with dizziness, and gradually mental symptoms appear. They are, first, indifference, second, slow cerebration, and, third, coma may develop. As this is an acute subperiosteal infection, and is liable to extend through the periosteum and inflame the soft structures, it may produce meningitis or brain abscess. This is all the more reason why the irritation or inflammation of the periosteum should be recognized early and treated as any acute, subperiosteal infection; that is, by relieving tension, thus arresting the progress of the disease. This can be done only by opening the skull, exposing the dura or periosteum, and thereby establishing free drainage. The dura or periosteum should not be opened. I will now present a case belonging to this class.

Mr. W., Hungarian, laborer, married, age 31. Six weeks before presenting himself at the University Hospital he complained of severe earache. Shortly afterward there was a discharge from the external ear. He went to a physician who irrigated the external auditory meatus, but his symptoms grew steadily worse. At this time a swelling developed back of the ear. He went to a second physician, who repeated the irrigations and gave him a syringe, telling him to wash out his ear at frequent intervals. His pain, however, did not subside. He went to a third physician, whose sign read, "Specialist in Ear, Nose and Throat." This "specialist" promised to cure him.

Treatment. Three leeches were applied back of his ear and he was given a hypodermic injection of vaccine, told to return in two days for another treatment, when again the leeches were applied and he received a second injection of vaccine. Two days later he complained of a terrible headache and vomited. When I saw him he had slow cerebration, no leucocytosis, normal temperature, slow pulse, increased blood pressure, and cerebral vomiting at intervals. I advised immediate operation, for I was confident the man had a mastoiditis that had extended to and was irritating the dura or periosteum. He was taken directly to the operating room. As soon as an incision was made through the skin and the outer wall of the mastoid antrum removed pulsating pus escaped in large quantities. The roof of the mastoid antrum was found necrosed and the granulated dura or periosteum presented itself. A plate of skull was removed above the mastoid process so as to establish free drainage. The lateral sinus was exposed to the extent of two-and-a-half inches. The wound was left entirely open, with the dura or periosteum exposed. The patient was in a critical condition for two days, after which time he made a rapid and uneventful recovery.

The third case I wished to present was one of hypertrophic periostitis with necrosis of the skull following acute mastoiditis.

In 1912, the patient developed acute mastoiditis on the right side, followed by an extradural or subperiosteal abscess. After suffering from severe headaches for a year and half the mastoid was operated upon but the extradural abscess was overlooked. In 1915 she came to me; I reoperated upon the mastoid and drained the extradural abscess. The pain was relieved for some time but within eighteen months the pain returned repeatedly and I have operated upon her seven times for localized extradural abscesses in different areas of the skull. I have removed in all twenty-three and one-half square inches of skull. For the last 16 months she has been free from pain.

To establish a diagnosis in these cases we have carefully considered the history, complete laboratory and X-ray findings, and in the recent ones have had the benefit of the serologic localization test of Abderhalden. I wish to emphasize the fact that in the cases of cerebral irritation due to deposits of lime salts on the dura or periosteum, a flat X-ray plate is absolutely valueless. The only plates that can be relied upon are the stereoroentgenograms, and these must be made by an expert and at least three sets of plates should be made by concentrating the rays upon three different areas of the head. The flat X-ray plate will not show the deposited lime salts when taken through the skull, as being independent of the bone, and it is only the stereos that will show that the deposit is not a part of the skull, but lies a short distance internal to it.

I want to state further that a set of stereo plates are useless unless there is some one to read and properly interpret the findings that have been produced upon the plate.

The serologic work as done at the Durand Hospital by Dr. Retinger has opened a new field in diagnosing and localizing brain lesions. In cases as above cited I believe this work will be of value and is fairly reliable and will become more and more beneficial as Dr. Retinger continues his research. But should it fall into the hands of the general laboratory worker, with careless and slipshod methods, it will fall into disuse and be thrown in the discard and science will be the loser. So let an attempt be made to keep this work in the hands of the conscientious, careful worker, as work of this kind must be done by an especially trained and extremely careful man.

A PLEA FOR CLOSER CO-OPERATION BETWEEN THE ROENTGENOLOGIST AND THE GENERAL SURGEON

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A PLEA FOR CLOSER CO-OPERATION BETWEEN THE ROENTGENOLOGIST AND THE GENERAL SURGEON

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Mr. President and Members of the Western Roentgen Society: The title of this paper does not entirely convey to the author the correct idea, for he believes the Roentgenologist is indispensable to the surgeon and should be a part of his working team, and is as essential in many instances as a specially trained and skilled anthetist, chemical laboratory expert or surgical assistant is necessary to enable him to procure for the patient the best and most satisfactory post-operative results. The word coöperation should be association or affiliation.

I wish to speak frankly and try to express clearly my opinion of the close relation of the *x*-ray laboratory and its management to the general surgeon so he can give his patient the maximum benefit of the services rendered with the minimum expenditure of the patient's energy.

First and paramount it is necessary to obtain a detailed history as well as the past and present symptoms of the patient and correctly interpret the relation of these to the physical findings procured by the usual methods of examination. These old and time honored truths must not be cast aside for newer works, no matter how beneficial an aid the new science may prove itself to be, for the *x*-ray like other laboratory reports are of the greatest value when they corroborate the physical findings and are an aid to account for symptoms by revealing pathology not sufficiently advanced to be detected by the old methods.

Careful roentgenoscopic examinations and good roentgenograms will reveal to the keen observer early pathological lesions and many abnormalities that otherwise would be undisclosed by the usual procedure of examination. Pathological lesions will be discovered, their location and the structures involved would lead one, if found with our present day methods of physical examination, to believe that pathognomic symptoms should long since have been produced; but the patient during the taking of a most careful history has suggested nothing that would lead one to suspect the existence of such lesion. In such cases it is only the most skilled and experienced technicians that are able to render invaluable service to the surgeon After the discoveries are made the questions then to be considered are:

1st—The probable duration of the existence of such lesions, whether congenital abnormalities or acquired conditions.
2nd—The liability of symptoms arising or damage being done if the conditions are not corrected.
3rd—Should these conditions be corrected by surgical interference?
4th—The age and condition of the patient to withstand a surgical procedure that such correction would require.
5th—The amount of good to be accomplished by attempting surgical relief, whether permanent, to prolong life or only to relieve suffering.

I am a firm believer that there should be a definite scientific reason for subjecting a patient to an operation. I would not have you think for a moment that I believe every patient must be a sufferer before surgery is to be advised, but I would like to be understood as believing that present suffering should be relieved and anticipated future suffering avoided by the performing of an operation. If it is our conscientious belief after due and careful consideration that present non-symptomatic lesion accidentally discovered will in the near or remote future cause impairment of health or happiness, shorten one's life or usefulness, and there is reason to believe that such lesion can be corrected by surgery; then I say operate while the patient is in as good a physical condition as possible, the sooner the better. It is in such cases the roentgenologist and surgeon, acting in unison, must be alert and correct in the interpretation of the roentgenoscopic or roentgenographic findings and be cognizant of the price the patient must pay for undue haste or delay.

I believe the roentgenologist should be a physican and a good one at that. He surely must be an anatomist and be conversant with the normal relations of structures, as well as the symptoms apparent abnormal findings should produce. He should be a thinker and each case is to be studied as an individual one and not as one belonging to a certain group or class of similar cases. He should not be an alarmist, nor should he be over cautious. Above all not only should he be a manipulator of an *x*-ray outfit, but must be able to render a just and correct diagnosis of what his machine reveals to him without being influenced by the surgeon's opinion. After noting his findings and opinions, the surgeon and roentgenologist than have a further duty to perform, and that is the unbiased opinions of both must be blended into a single idea which must be based upon findings, symptoms and results to be obtained if surgical work is to be done.

If the work requires plates, they should be of a proper size and so developed that the structures to be observed stand out clear and distinct so there can be no mistake as to the minutest pathology. One should remember that a picture of a foggy day leaves much to the imagination and the enemy may be upon us before we are aware of his presence, or he may be retreating and getting out of range and, to our surprise, when the fog rises and a clear picture is brought to view, there has been a great waste of ammunition and delay in advancing.

The mangers of *x*-ray laboratories that take plates develop the same, charge for work in accordance with the size of the plate and difficulty of handling them, irrespective of what they reveal, all the time impressing upon their victims that, the larger the plates the more they are getting for their money. The unwieldly, developed plates are then turned over to the patients as their property. Immediately they go forth with their cherished false idol to their physician or surgeon or to many physicians and surgeons, thereby getting many unintelligent and incorrect opinions of incompetent and unscrupulous judges, until they believe in or trust no one. They stagger under the load of different opinions, lose faith in all physicians and turn to Christian Science for relief and then for the first time they get a unison of opinion from all they consult. Christian Science and similar cults can exist only in direct proportion to our shortcomings.

Such laboratories, if they exist, are I believe a menace to the public at large and are surely a handicap to the advancement of scientific roentgenology.

The ideal location for an *x*-ray laboratory is in a hospital, readily accessible and working in unison with the other laboratories. However, the great percentage of our population is in the rural districts and they should by no means be deprived of the convenience and benefit of such *x*-ray work as can be done conscientiously and scientifically by their local physician. I have many times seen much better work done in laboratories in small villages than I have seen turned out by elegantly furnished laboratories in our large cities and medical centers.

In special lines of surgery, for instance the head and spine,—I mention these for it is the line of surgery in which I am especially interested—flat plates are valueless or of little value. The stereo-roentgenograms concentrated on definite areas are of the greatest value. To secure the knowledge required in head work at least three sets of stereo-roentgenograms of the lateral view, one for each of the fossa, should be taken. For the spine one should be taken for every two or at most three vertebrae if we are seeking for minute defects.

Lastly, the roentgenologist should be a business man, as should all professional men. He and his family must live and so must the surgeon that is associated with him. His fees must be in reach of the masses or like other professional necessities the cities and states will operate at the tax payers' expense free laboratories for the deserving poor and these laboratories will be the same menace to the public and our profession as our free dispensaries are at present. The deserving charity will be crowded out by the parasites, who need all their money to keep up appearances, but are professionally the dead beats able to pay, imposters. The last class of patients should be handled by the closest coöperation of all professional men, irrespective of their specialty.

I believe in good pay for high grade services. A sufferer is, I believe, entitled to the benefits of advanced science whether he be rich or poor, but the professional man should no more be expected to render his services gratis than the butcher or baker or any business man should be expected to give his stock of goods to the poor without remuneration.

Finally, let me make a plea for closer coöperation, not only of the roentgenologist and surgeon, but of the roentgenologist and all in our profession. A coöperation not only for our science and our financial betterment, but for the benefit of humanity by the earlier recognition of the beginning ravages of disease than has been our privilege heretofore and a united effort to discover ways and means to arrest the progress of such disease before irreparable damage has been done. Only by such coöperation can roentgenology, which is at present only in its infancy, be rapidly developed into its possibilities.

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FRACTURES OF THE LOWER END OF THE RADIUS

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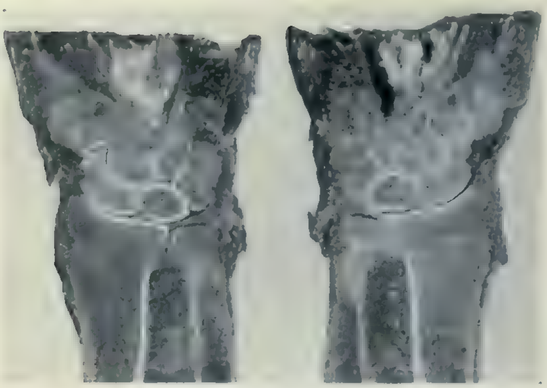
THE subject of fractures is as old as the human race and I will make no attempt to advance anything new. But it is my desire so to stimulate renewed interest in this very large and extremely important branch of surgery, and by calling your attention to the following facts to remind you that the treatment of fractured bones has not as yet become a perfected science.

The surgeon who makes it a part of his practice to treat fractures is confronted by these facts with increased frequency: that to treat fractures according to modern surgical principles necessitates the aid of a competent roentgenologist, a very thorough knowledge of human anatomy, a considerable amount of mechanical ability, a definite understanding of the pathological changes that may take place during the process of repair of the bone, expert operative technique, a wide experience and good surgical judgment.

Like the term "rheumatism," the term "Colles' fracture" covers a multitude of conditions, and as the term "rheumatism" is applied to many forms of arthritis, so also is the term "Colles' fracture" used to describe many types of fractures of the lower end of the radius, as well as at times including lesions in the lower end of the ulna.

Hamilton, in 1860, in his treatise on "Fractures and Dislocations" used the term "so-called Colles' fractures," intimating that then, as well as now, the term conveyed an indefinite idea, and his use of the phrase, "the peculiar character of the displacement which characterizes the Colles' fracture," would indicate that the fractures without displacement or those with a different type of displacement were not then classed as Colles' fractures; while today the term is so loosely applied that most fractures about the lower forearm region are spoken of as Colles'. That a Colles' fracture is a rather definite lesion and due to quite a definite mechanical force is well understood, but this fact is too often lost sight of in the descriptions of the various fractures involving the lower end of the radius. Observation has taught us that there are many injuries in this region that are not of Colles' type and cannot be treated as such. While there are a great many discrepancies in the descriptions of this type of fracture which Colles described, about one hundred years ago, yet the concensus of opinion gives Colles the credit for having described the most common type of these fractures. It is characterized by the so-called "dinner fork" deformity, with the line of fractures within three-fourths of an inch of the lower articular surface of the radius, and extending obliquely downward and forward, thus permitting the lower fragment to be displaced upward and backward. This causes the articular surface of the radius to look slightly dorsalward and more toward the thumb, and the styloid process of the radius to be raised to the level of the ulnar styloid or even a little higher and giving the hand a position of slight radial adduction, thereby producing a distinct prominence of the lower end of the ulna. It seems quite evident that many of the less severe fractures of the lower end of the radius were not recognized as fractures and thus not considered by Colles, and perhaps this was better for the patients, for as I will endeavor to show later, some of these fractures offer a better prognosis by no treatment at all than would be the case if they were recognized by the X-ray and, as so often happens, were overtreated. However, many of these serious lesions are not X-rayed and are thus too often mistaken for minor injuries and are not properly treated. The late John B. Murphy stated at the meeting of the American Medical Association, in 1912, that 85 to 92 per cent of Colles' fractures resulted badly as they were then treated. This percentage, it would seem, is a little high, and, it is quite likely that Murphy's statement was based



Figs. 1 and 2. Longitudinal sections of the wrist-joint showing the relations of the carpal bones to the radius and ulna. Note that the force of violence may be transmitted to the ulna as well as to the radius, and how readily callus may be deposited about the various articular surfaces, following fractures.

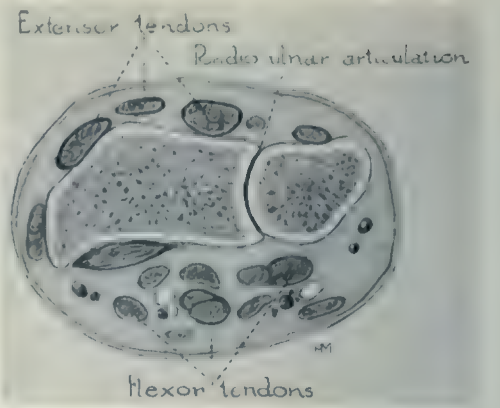


Fig. 3. (1) Note the extent of the radio-ulnar articulation, which is frequently involved in the fracture and will be filled with callus if precautions are not taken to prevent it; (2) note the close proximity of the extensor tendons on the dorsal and internal-lateral surfaces, which will be included in the adhesions about the fracture when it is immobilized for too long a time, and (3) note further the numerous flexor tendons that may be included in the inflammatory reaction of the more severe cases and lead to adhesions if flexion and extension of the fingers are not insisted upon after the first two or three days.

upon his personal experience with referred cases, which to a large extent were probably those that had been carelessly treated by the general practitioner, before they found their way into his clinic.

Every surgeon who has treated this type of injury often, or has seen a large number of cases, will doubtless recall some that have resulted badly, and others that should have yielded better results, and can recall cases treated by other men in which the results were far from ideal. Who of us will not agree that we should turn our attention for a time to the treatment of these common and serious lesions and thereby establish some better methods, or institute a campaign of education that will enable the average physician and general practitioner to better use our present methods?

ETIOLOGY

The fractures involving the lower inch of the radius are largely limited to middle and advanced life and a very large percentage occur after middle life.

Very few fractures in this region are found in individuals under twenty, and when such an injury does occur it is prone to involve the epiphyseal line. It is the youngest that falls most frequently upon the outstretched hand, and yet suffers so rarely from any bone lesion, and when the violence is sufficiently severe to produce a bone lesion it may involve the epiphyseal line, but more commonly the lower third of the radius with or without the ulna, or, rarely, results in some type of fracture about the elbow. (Figures 6 to 21 illustrate the types of fractures that may occur in early childhood as a result of a fall on the outstretched hand.) The type of violence that produces the more common fractures of the lower end of the radius is too well known to deserve comment at this time; but, why apparently similar types of violence produce such widely different varieties of fractures—see illustrations—is a question that invites considerable thought, and is a phase that should not be considered lightly when treatment is being carried out.

ANATOMY

A study of the anatomy of the wrist joint (Figs. 1 to 5) will show how easily the violence is transmitted to the lower end of the radius when the patient falls on his hand; it will further show that the violence is transmitted to the ulna by two avenues of contact: namely, through the radio-ulnar articulation and through the fibro-articular cartilage between the ulna and the semiulnar. It is

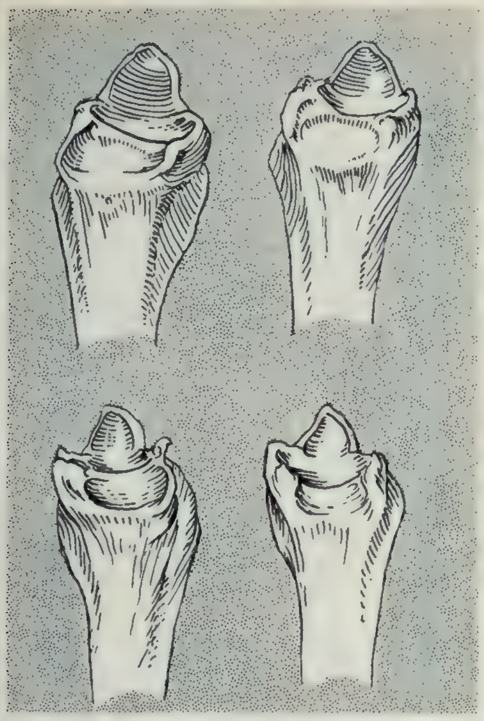


Fig. 4. Ulnar side of two right and two left radii. Note the extent and variation in the articular surfaces and the dorsal and ventral bony prominences. The line of fracture frequently enters these articular surfaces and they must be protected against the deposit of callus.

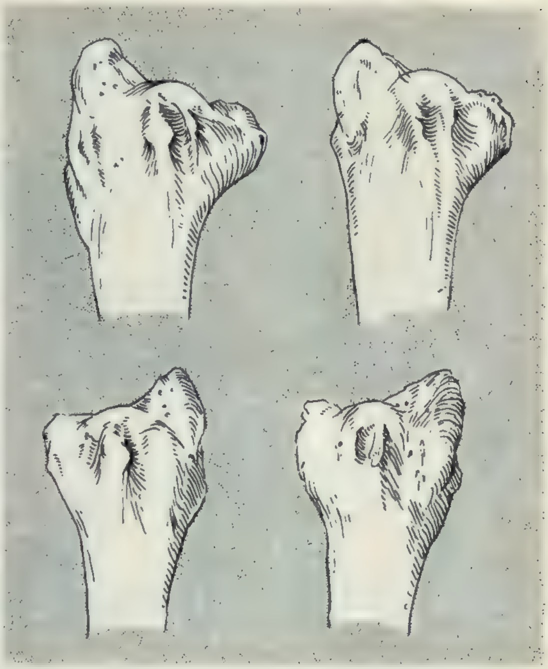


Fig. 5. Dorsal view of two right and two left radii. Note the marked variations in the styloid processes and other bony prominences. It is these variations that must be considered carefully when interpreting clinical and X-ray findings.

logical to suppose that the radius fractures primarily in these injuries and then, if the force of the violence is sufficient, the ulna will yield. A study of the sections will show that there exists a difference in the arrangement of the bones of the wrist and their relation to the radius and ulna which doubtlessly accounts in a measure for the variations in the line of fractures.

A study of the cross sections of the forearm at the level of the radio-ulnar articulation will show how intimate is the association of various tendons and how they are brought into immediate contact with the fractured radius at this level, on both ventral and dorsal surfaces. This fact should be uppermost in the mind of the operator who is treating one of these fractures.

PATHOLOGY

In the discussion of fractures, the term pathology seemingly conveys only the picture of the various changes that take place in the bone, as a result of the injury and during the process of repair, while the ultimate outcome of a great many fractures depends far more on the pathological changes that occur in the soft parts, not so much those that occur at the time of injury, but those that are prone to occur during the repair of bone.

That every fracture of bone is complicated by injury of the surrounding soft parts is a fact that needs no comment, but in some fractures considerable changes are thus produced, also inflammation the severity of which is in direct proportion to the extent of the primary injury to the soft parts, or as may be aggravated by the treatment used.

When a fracture occurs at the lower end of the radius or in any of the bones which make up the wrist-joint, there is rarely any extensive primary injury to the surrounding soft parts; yet the structures are so numerous and lie in such close proximity to the injured bone that soon after the bone lesion occurs

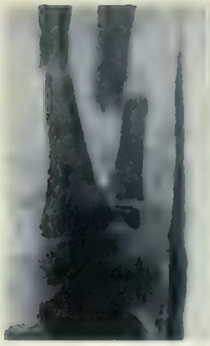
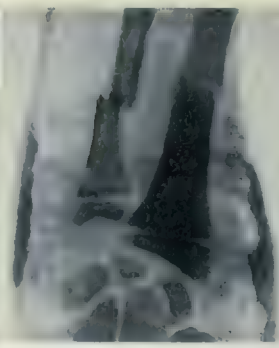


Fig. 6.



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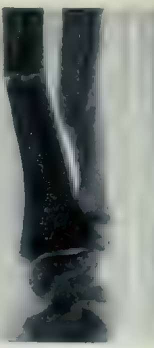

Fig. 8.

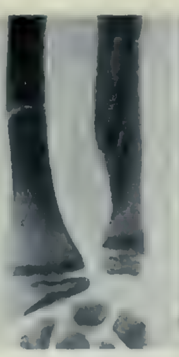

Fig. 9.

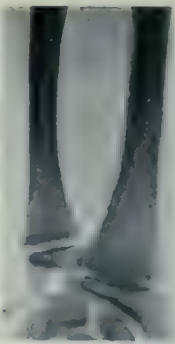

Fig. 10.

Figs. 6 and 7. T. P., age 9, on September 10, 1914, fell on the outstretched hand. Signs of fracture were very evident. After reduction, a circular cast was applied and after four weeks union seemed firm. Note that the radius fracture was incomplete and there was no displacement. Note too that ulna was allowed to unite without reduction.

Figs. 8 and 9. Same case as 6 and 7, returned to us December 23, 1914, less than three and a half months after the first injury, with a similar history and injury. Note the radius fractured at the same level while the ulna remained united. Note the ulna united firmly with the fragments displaced.

Fig. 10. Same case as 6, 7, 8, 9, now aged 12, returned to us on October 30, 1917, for other troubles. Note the complete restoration of the ulna with its medullary canal with no evidence of the old fractures. Note, however, the same shortening of the ulna in Figures 7, 9, and 10, which is not manifest clinically nor does it disturb the function of the arm in any way.

extravasation of blood and infiltration of leucocytes involve, to a greater or less extent, the delicate membranes lining the numerous tendon sheaths and synovial cavities which become roughened and lose temporarily that smoothness, which permits the free transmission of tendons and articular surfaces. As the inflammation progresses, more or less effusion takes place into the structures and, during the process of repair, if conditions are not favorable, how easily adhesions may form between the tendons and their sheaths, or connective tissue infiltration take place about the various joints, which may also involve the tendons, and which will interfere very markedly with the free movements of the many structures that are so essential to the normal function of this important joint. It is just these pathological changes that are responsible for a large percentage of the poor functional results in these fractures. When such changes have taken place we have pathological conditions far more difficult to treat than the original fracture.

The line of fracture in the lower end of the radius ranges very widely as will be seen by a study of the illustrations. When it is recalled that a large percentage of these fractures occur within an inch of the lower articular surface of the radius, it will be seen that a great many times the line of fracture will enter the radio-ulnar articulation. A few will enter the wrist-joint and in either case callus may be deposited over and about these surfaces if precaution is not taken to prevent it. Displacements of the fragments vary as widely as does the line of fracture. In no small proportion of these cases there is no appreciable displacement, even though the line of fracture may be complete and extend in almost any direction. On the other hand, the displacement may be so marked as to produce a very distinct change in the position of the hand and wrist as well as the lower articular surface of the radius, which in the large percentage of cases is made to look backward and downward. Two fragments is the rule, but there may be three or many and the smaller fragments be displaced in any direction. It is these latter cases that are apt to be followed by pathological changes in the soft tissues.

VARIETIES

I have made no attempt to classify these fractures. Roberts and Kelly have given a very comprehensive and yet confusing classi-

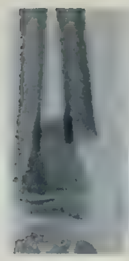

Fig. 11.

Fig. 12.

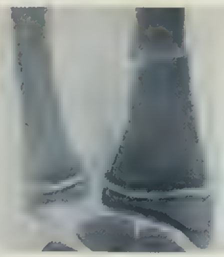

Fig. 13.

Fig. 14.

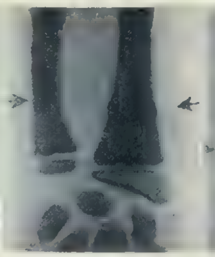

Fig. 15.

Fig. 16.

Figs. 11 and 12. D. B., age 11. Usual history and signs of fracture present. A circular cast was applied for four weeks; function good in five weeks.

Figs. 13 and 14. H. E., age 9. Usual history and sign of fracture, radius alone fractured. A short period of immobilization was sufficient to restore a normal condition.

Fig. 15 and 16. S. A., age 7. Usual history and signs of incomplete fracture. After three weeks the patient was permitted to carry the arm in a sling without splints. The mother allowed child to go out on roller skates and the following day he returned with arm bent again. A longer period of immobilization gave a perfect functional result.

fication in which they describe fourteen varieties with fifteen subvarieties or twenty-nine different types of fractures of the lower end of the radius.

DIAGNOSIS

In Figures 1 to 5, note that there is a variation in the position of the lower articular surface of the radius; that the radio-ulnar articular surfaces are much larger in some cases than others and may be easily involved in these fractures; that trauma of the carpal bones may be readily transmitted to the ulna by means of the fibro-articular cartilage that intervenes; that there is not a fixed ratio between the level of the two styloid processes.

A study of hundreds of wrist-joints in the dissecting rooms shows a very wide difference in the articular surfaces of the lower end of the radius and ulna. In a few cases the ulna has little or no connection with the wrist-joint, while in most specimens it has a distinct articular surface. The bony prominences of the ventral and dorsal surfaces of the lower end of the radius show a very wide variation which must be remembered during the interpretation of X-ray plates and also in determining clinically the amount of deformity.

The direct diagnosis of fractures about the wrist-joint resolves itself into the diagnosis of fractures without any or all classical signs of fracture in a great many cases. For in a certain percentage of these cases the objective signs of fracture are absent, there being no deformity, false point of motion or crepitus, and the signs of local trauma may be less marked than are often present following a severe sprain, while in the absence of such findings the X-ray plate will often show a fracture. The extent of the swelling, extravasation and ecchymosis is largely dependent upon the amount of injury to the soft tissues and not the bone. The subjective symptoms of fracture, as history of injury, pain, and loss of function, are always present in these injuries. The signs of an ordinary fracture and those of the Colles type are too well known to warrant a repetition now, but, there is one sign present here which is almost pathognomonic of fracture in any superficial bone, and that is, an area of extreme tenderness along the line of fracture. This point has been called attention to by Speed and others, and is a very dependable sign in fractures of the ribs; those about the elbow as well as in those under consideration; and, when all other signs of fracture are absent, a very definite diagnosis can be made in the early hours by finding this point of extreme tenderness. It is so characteristic and so definite that the location and line of fracture can be outlined before the roentgenogram is seen. In all these fractures the roentgenologist should be consulted before treatment is instituted and in some cases during the progress of the condition. Miller's assertion that "in no place in the body are serious injuries mistaken for minor ones so fre-

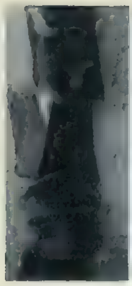
Fig. 17.

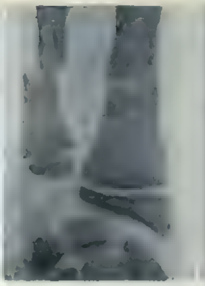
Fig. 18.

Fig. 19.

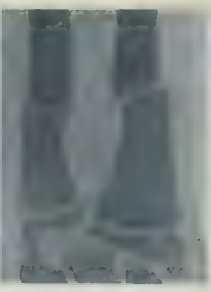
Fig. 20.

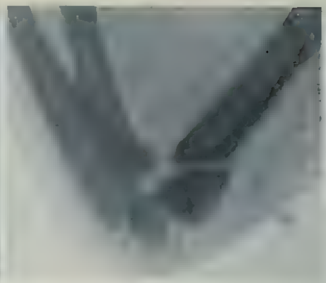
Fig. 21.

Figs. 17 and 18. R. C., age 13, on September 1, 1917, while playing ball, stepped on a potato and fell on both hands. The usual signs of fracture were present together with two small punctured wounds on the ventral surface at the level of the lower end of the upper fragments, where the bones had penetrated the flesh. Careful antiseptic treatment resulted in union without infection and return to normal function in five weeks.

Figs. 19 and 20. However, the patient returned on February 24, 1918, having fallen while roller skating and again showed the signs of fracture with marked deformity, which was reduced under anæsthesia. The line of fracture in both bones is shown to be very near the site of the original injury.

Fig. 21. V. G., aged 7, gave a history very similar to that in cases shown in Figs. 6 to 20. The patient fell while hurrying home to dinner. The symptoms indicated backward dislocation of the elbow. The dislocation was reduced under anæsthesia, but the X-ray showed a transverse supracondyloid fracture which gave evidence of never having been displaced. This illustrated the two rarer types of injury that may occur in a child, by a fall on the outstretched hand. The arm was dressed in extreme flexion, and early and frequent massage and passive movements, together with removal of the dressing in three weeks, resulted in a straight arm with almost complete flexion and extension in two months.

quently as are injuries about the wrist," would not be true if all wrist injuries were X-rayed.

Arbitrary statements and hurried conclusions about the presence or absence of bone injuries, especially near joints, are inexcusable when the services of a roentgenologist can be secured.

DIFFERENTIAL DIAGNOSIS

To differentiate the various bone lesions about the wrist-joint is quite essential from a therapeutic standpoint, as displacements must be corrected and articular surfaces protected. In all cases of injury about the wrist-joint the court of last resort, the X-ray, should be universally employed. However, if

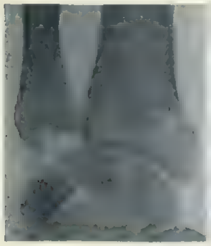
Fig. 22.

Fig. 23.

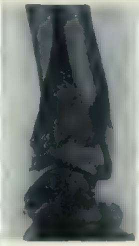
Fig. 24.

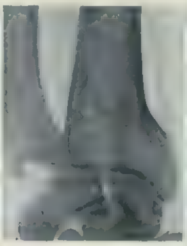
Fig. 25.

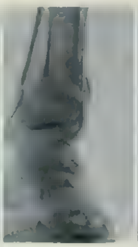
Fig. 26.

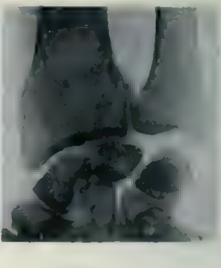
Fig. 27.

Figs. 22 and 23. Mrs. F. G., age 48, gave the usual history of a fall on the outstretched hand. Signs of fracture and typical "dinner fork" deformity were present. A circular cast was applied with the hand slightly flexed for ten days, then in mid-position. Note that the line of fracture enters radio-ulnar articulation. Immobilization was discontinued at the end of three and a half weeks. Passive movements and massage were used early and frequently and the patient returned to her work as a coat maker at the end of six weeks.

Figs. 24 and 25. Same case 22 and 23; two and one half years later. The wrist is clinically and from X-ray findings practically a normal one. Both views here will show what result can be obtained under favorable conditions.

Figs. 26 and 27. Mrs. R. S., aged 38, gave usual history but usual signs of fracture were absent; line of tenderness marked; signs of trauma slight. No reduction necessary or attempted. Circular cast removed in three weeks. Frequent massage and passive movements administered and function restored with only slight deformity remaining.

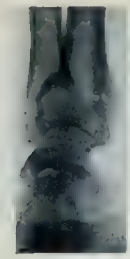

Fig. 28.

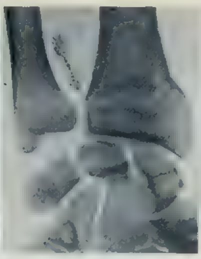

Fig. 29.

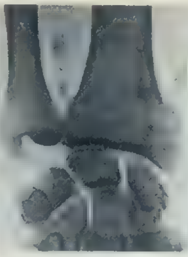

Fig. 30.

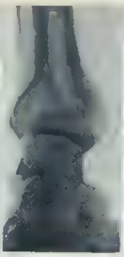

Fig. 31.

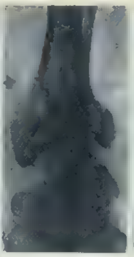

Fig. 32.

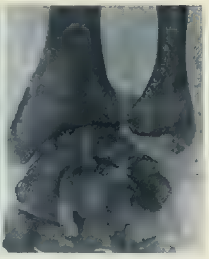

Fig. 33.

Figs. 28 and 29. Miss D. M., age 20. Usual history and typical signs of "dinner fork" deformity were present. The signs of trauma were marked. Reduction was accomplished by ulnar adduction and flexion. Note line of fracture enters the radio-ulnar articulation. A circular cast was applied and a moderate amount of massage and passive movements administered and the patient returned to her factory work at end of five weeks.

Figs. 30 and 31. Mrs. A., age 50, very stout, gave the usual history, but the signs of fracture were absent. The line of tenderness was well marked. The signs of trauma were moderate. No reduction was necessary. Note that the line of fracture runs close to the radio-ulnar articulation. A circular cast was applied and very frequent and vigorous passive movements and massage were administered with result that function was completely restored.

Figs. 32 and 33. Mrs. R., age 74, fell with wrist flexed. The usual signs of fracture were absent. The line of tenderness was marked and signs of trauma slight. No reduction was necessary. A circular cast was applied for three weeks, and frequent massage and passive movements were administered. Function was well restored in six weeks.

the surgeon be true to himself and to his patient, he will not become dependent upon the X-ray, but he will make sure of his clinical findings first, draw his conclusions as to treatment, and resort to the X-ray to confirm his findings or to prove positively the absence or presence of a bone injury in the more obscure cases, and to trace definitely the line of fracture, a knowledge of which is essential to proper treatment.

Many cases of severe sprain after twenty-four to forty-eight hours may simulate a fracture very closely, but to conclude that it is a fracture without positive proof is shirking the responsibility and doing the patient an injustice. Not wishing here to belittle the importance of a sprain, I feel it my duty to state that a sprained joint should be protected, not necessarily immobilized, much longer than a joint about which a fracture has occurred.

TREATMENT

When we consider the wonderful advance in abdominal and other branches of surgery in the past quarter of a century we feel elated and are bold to acclaim what has been accomplished; but when we are confronted with the facts, that such fractures as are under consideration, were as carefully described, and seemingly as well treated or even better back in the days of Sir Astley Cooper when he wrote his *Treatise on Fractures* in 1844, as they are today, and with the statement of the late J. B. Murphy made in 1912, that 85 to 92 per cent of Colles' fractures as treated today result badly, are we going to shift the blame, or are we going to stand like men and "admit the goods"? The field of operative surgery has so engrossed the attention and enthusiasm of the surgeons of today that the subject of fractures has been woefully neglected, both in practice and in teaching. The average student of today when ready to leave college knows much better the details of an operation for appendicitis or hernia, or even hysterectomy, than he does the details of the treatment of the most common fractures, yet he is no sooner comfortably located in his new office than he is called upon to treat a Colles' or a Pott's or a fracture of even more serious nature and he applies as best he can what he has learned, to the everlasting detriment of his patient, and, at times, a dissatisfaction that may end in a suit for malpractice. Is the young physician or surgeon entirely at fault? No. The principal responsibility falls back upon those whose duty it is to teach the subject of fractures more thoroughly. As Phemister has intimated, if the term Colles' fracture were dropped from the descrip-

Fig. 34.

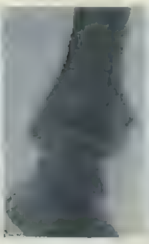

Fig. 35.

Fig. 36.

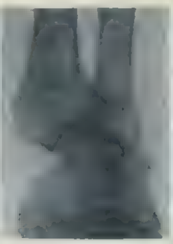

Fig. 37.

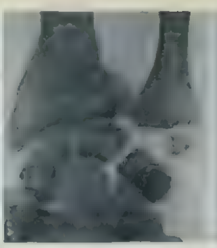

Fig. 38.

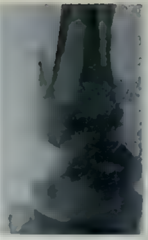

Fig. 39.

Figs. 34 and 35. C. S., age 47, injured by back fire of auto truck. The usual signs of fracture were absent, there was no deformity, but the signs of trauma were quite well marked. Note that the line of fracture reaches radio-ulnar articulation. No reduction was necessary. A firm circular cast extending from the bend of the fingers to the middle of the forearm was applied and the patient returned to work driving his truck after the fourth day, using his left hand for cranking and steering his machine. Vigorous massage and passive movements were given every four or five days and the cast removed at the end of four weeks.

Figs. 36 and 37. Mrs. E. D., age 60, gave the usual history. The deformity was very marked. The signs of trauma were also marked. Note the peculiar line of fracture and displacement with articular surfaces of radius looking backward. The patient was intoxicated and a fair reduction was accomplished without anæsthesia. A circular cast, applied with hand flexed, was worn for three weeks. The usual massage and passive movements were administered. Functional result good.

Figs. 38 and 39. Mrs. K. T., age 42, gave the usual history. The deformity was moderate and typical; signs of fracture obscure. Note irregularity in line of fracture, and that radius shows but slight shortening. An unsatisfactory attempt at reduction was made. A circular cast with hand slightly flexed was applied. Immobilization was discontinued at the end of 20 days. The patient returned to work as housekeeper after four weeks. After one year the patient returned. An unaccountable shortening of the radius is manifest with relaxation of the radio-ulnar ligaments and quite free anteroposterior movements of the ulna.

tions of fractures about the lower end of the radius, and the more common types described according to the pathology produced, and thus present a firm basis upon which logical measures for treatment could be founded, the results obtained in the treatment of such lesions would be nearer the ideal. To classify all fractures about the lower end of the radius under one heading and call them Colles' and treat them as such, is absurd. To treat a transverse, impacted, slightly displaced fracture in this locality as the so-called Colles' is also absurd and ridiculous. That the treatment should vary according to the line of fracture, if impacted or unimpacted, the displacement, the amount of injury to the soft parts and thus swelling, and the age of the patient is logical, and only when such principles are followed will the results approach the ideal.

REDUCTION OF THE FRACTURE

The details of the various methods of reducing Colles' fractures are too well known or easily found in the various texts to justify repetition at this time. However, to assume that a reduction is to be accomplished in all, or in most fractures, of the lower end of the radius is wrong, and a study of the various types of lesions will soon convince one that in a great many of these fractures the fragments are in as near normal position as could be desired. However, in some of these fractures, a good reduction or a perfect reduction is essential to secure a good functional result.

McCurdy states that "Colles' fractures when not properly reduced at the time of the accident result in more bad deformities than all other fractures combined." It is a well known fact that fractures of the shaft of long bones with great deformity will unite and give good functional results (see Figs. 6 to 10), but not so with fractures about the joints and especially about the wrist. Brothers states that "a perfect functional result is not enough but that a perfect anatomical result is also expected." True it is, it would seem, that a perfect functional result is scarcely compatible with anything less than a perfect anatomical result. Hertzberg and others lay great stress on the importance of good reduction in these fractures, yet at times I have found that a good functional result may be obtained in some cases where reduction is far from perfect.

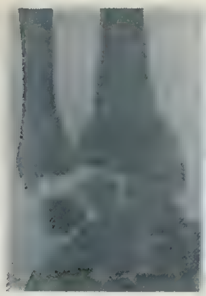

Fig. 40.

Fig. 41.

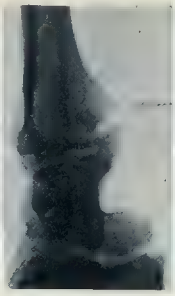

Fig. 42.

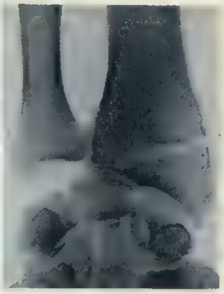

Fig. 43.

Figs. 40 and 41. Mrs. E. R., age 52, gave usual history. Accident happened seven days ago. The deformity is quite typical but the swelling obscures the bony findings. Note the comminuted fracture and unusual displacement. The patient refused an anæsthetic and but little could be accomplished in the way of reduction. A circular cast applied in mid-position was worn for ten days; massage and passive movements. Results, good motion and function but deformity persisted.

Figs. 42 and 43. S. R., age 36, fell from step ladder. There was no deformity; the signs of fracture were absent and the signs of trauma slight, but the line of tenderness was very evident. Note line of fracture enters radio-ulnar articulation near the wrist-joint. Note also marked natural prominence on ventral surface of radius. No reduction necessary. Usual treatment was administered and the patient returned to work as a painter at the end of three weeks.

IMMOBILIZATION

That proper immobilization in some of these fractures is essential, that some need very little if any, and that others may be immobilized for too long a period, are facts that must be considered carefully when one of these cases presents itself for treatment.

Lucas-Champonierre in his earlier years was a strong advocate of the mobilization method of treatment of fractures and while in his later years his views changed some, yet he was a firm believer in the use of the simplest immobilizing apparatus and in most cases the immobilization should be continued only for a short period of time. A great many of the later writers as Mennell, Cotton, Preston, Speed, and others, are in favor of a short period of immobilization.

To treat any fracture without some immobilizing apparatus is contrary to the principles which we see manifest in nature, and that are universally employed during the repair of wounds in any tissue; yet, I believe many fractures are too well immobilized and for too long a period.

Fractures of the lower end of the radius may be immobilized by any material that will suffice to maintain the wrist-joint in a rigid position, but the padded splints or the plaster casts are unquestionably the most serviceable, and it is my opinion that plaster of Paris when properly applied is the splint par excellence for all of these injuries and should extend from the bend of the fingers to the middle of the forearm in mild cases, or to near the elbow in the more severe cases. In those fractures that are transverse or that are not complicated with displacement, the hand should be maintained in the normal relation to the forearm, in midpositions, while in those of the so-called Colles' type with an original displacement and the articular surface of the radius looking downward and backward, the hand should be maintained in the semi-flexed position, and if displacement is prone to recur, in the pistol position. Immobilization of the elbow in these cases should be discouraged. Rotation should be carried out during treatment, otherwise callus may be deposited about the radio-ulnar articulation and thus interfere with supination and pronation.

The plaster cast should be applied like a circular cast over a moderate padding of sheet wadding and before the plaster hardens a strip from one-half to an inch wide should be cut out along the dorsum to provide for swelling that might take place, and to enable the operator to remove the cast frequently for massage and passive movements and then re-apply it readily. This replaced splint or cast can be made as rigid and close-fitting as is desired by means of adhesive plaster and a roller bandage. The cast should never extend below the metacarpophalangeal articulations, and the patient should be encouraged to flex and extend the fingers frequently after the first two or three days.

AFTER-TREATMENT

After-treatment, which includes everything from the time reduction is accomplished and the first splint is applied, is more important in securing a good functional result than is the first aid or the reduction and application of the first splints.

That a great many patients with poor functional results from these injuries are the victims of bad surgery is well recognized and that they are suffering not from the results of the original injury but from the treatment which they received in the hands of a careless operator. To prove this statement I need only cite one case of a man aged 46 who suffered from a fracture near the lower end of the radius from a back fire of his automobile. Three months later he presents himself with a useless forearm and hand, but with little or no deformity and perfect union of the fracture. He states that his doctor immobilized his arm absolutely for seven weeks.

To those of us who see these injuries frequently that statement seems almost incredible, but under no other conditions could a man get so useless a hand and arm, when associated with this type of injury. Ashhurst, in 1915, cited several cases of poor functional results, and then relates that by various operations on the "soft parts" function was restored. Miller, in 1914, stated "that the patient should be warned during the dressing period that a certain amount of fixation and swelling will be present and often persistent when the dressings are removed." Wilensky, in 1913, cited two cases that came under his observation which had been immobilized seven and eight weeks and were thus almost rigid and useless. My experience would tend to show that all such results can be avoided if proper early *massage and passive movements* are instituted, and the immobilizing apparatus be removed at the proper time. Lucas Championierre was one of the earliest advocates of this line of treatment and was backed very forcibly by Mennell who gives a very comprehensive discussion of what is included in this method of treatment, to which all men treating fractures would do well to refer. Lucas Championierre claimed that *mild exercise* is essentially useful for repair, but that a violent one is detrimental. Mennell states "that in cases of fractures that involve joint surfaces the only hope of effecting a satisfactory reduction is to impart suitable movements to the joint."

We also find such men as Smith, Wilensky, Neuhoff and Wolf, Hoag, Fiedler, Preston, Cotton, and Speed are strong in favor of early massage and passive movements. That the massage and early movements should be intelligently applied is an important feature, and according to most advocates should be instituted between the second and seventh day. It should be repeated daily or every other day to the end of two or three weeks when the *splints should be removed entirely* and active motions with massage be carried out until full function is restored.

The manipulations should be gentle and yet thorough, should cause little or no pain and after the first or second day the passive movements should not be extensive lest they produce movements of the articular fragments and lead to excessive callus formation.

Delayed union or non-union in these fractures is not to be expected as it practically never occurs, and in from three to six weeks, depending upon the severity of the injury, the arm and hand should be functionally restored.

OPERATIVE TREATMENT

It seems doubtful if operative interference is ever indicated in these cases if the treatment of the case even approaches the rational. Exceptional cases may be benefited, but the question of function should take precedence over deformity in deciding on operation. Considerable return of function is compatible with distinct deformity.

CONCLUSIONS

My experience in the treatment of fractures and the study necessary in the preparation of this article enables me to conclude:

1. That the teaching of the subject of fractures is woefully neglected in the present-day medical schools.

2. That every fracture in this region, as well as in others, is a law unto itself and each case must be treated according to its merits.

3. That arbitrary rules and methods cannot be followed in the treatment of fractures any better than in operative surgery.

4. That the subject of operative surgery, especially abdominal and head surgery, has so engulfed the surgical teachers of the day that they have almost entirely overlooked fractures.

5. That the average physician considers the treatment of fractures lightly and thus neglects many of the essential details.

6. That patients today have a right to demand as efficient services in the treatment of their fractured bones as they receive for their appendix or gall-bladder.

7. That a competent roentgenologist is a valuable adjunct in the treatment of fractures but is not essential to obtain good functional results in a large percentage of the cases.

8. That the surgeon who treats fractures should appreciate the importance of the many details that are essential to perfect restoration of function.

9. That we are apt to err in immobilizing these fractures too well and too long rather than in the lack of immobilization and for too short a time.

10. That careful after-treatment is the essential thing in securing good functional results.

11. That early passive movements and massage are absolutely necessary to secure perfect and early return of function.

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Plastic Repair of the Heel

Clinic of

Dr. B. F. Lounsbury

Washington Boulevard Hospital
Chicago

Reprint from

SURGICAL CLINICS OF CHICAGO

June 1919

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CLINIC OF DR. B. F. LOUNSBURY

WASHINGTON BOULEVARD HOSPITAL

PLASTIC REPAIR OF THE HEEL

Summary: Demonstration of 3 cases in which large cutaneous defects over the os calcis have been repaired by the Italian method of skin transplantation; discussion of technic.

DURING the past five years I have had occasion to care for 3 unusual cases of injury involving the heel. The damage sustained was of such a character as to wholly incapacitate the man from physical labor, yet was not severe enough to warrant an amputation of the foot.

The problems to me were unique, and it is because of the unusual features of the cases that I thought them of interest enough to present to you. A brief history of the cases, with the methods employed, are as follows:

Our first case received an injury in 1913, which crushed the lateral side of the foot, destroying the distal end of the fifth metatarsal and little toe, and tearing away the entire pad of the heel and crushing the posterior tip of the os calcis. The ankle-joint and other structures of the foot were intact and the doctors in charge hoped to save a useful foot. At various times skin-grafts were applied until all the raw surfaces were covered. It was found, however, that an area over the end of the os calcis persistently broke down and remained as an open ulcer. The foot was in this condition in June, 1914, when he came under our care.

I had never before transplanted a flap over the end of the heel, but after placing the foot in various positions, decided that a flap could be elevated from the back of the thigh. This was done and the heel was held in a cast against the back of the

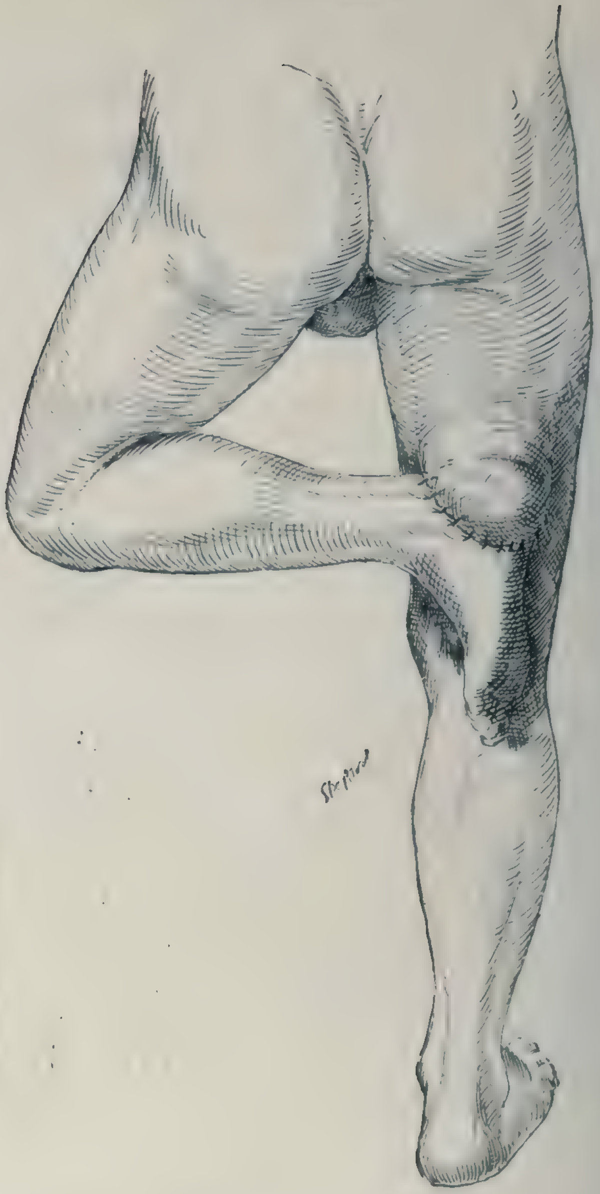

Fig. 171.—Case I. Diagram showing flap of skin from back of thigh in process of transplantation to cover cutaneous defect on the heel of the opposite foot.

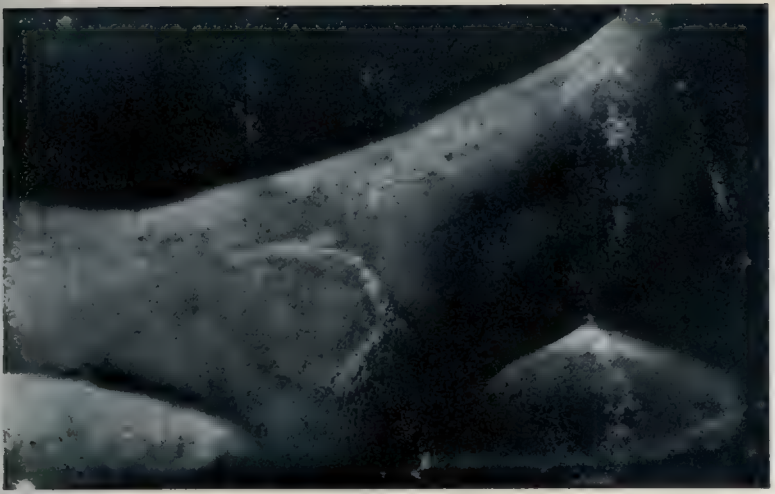

Fig. 172.—Case I. Medial aspect of site of plastic five years after operation.

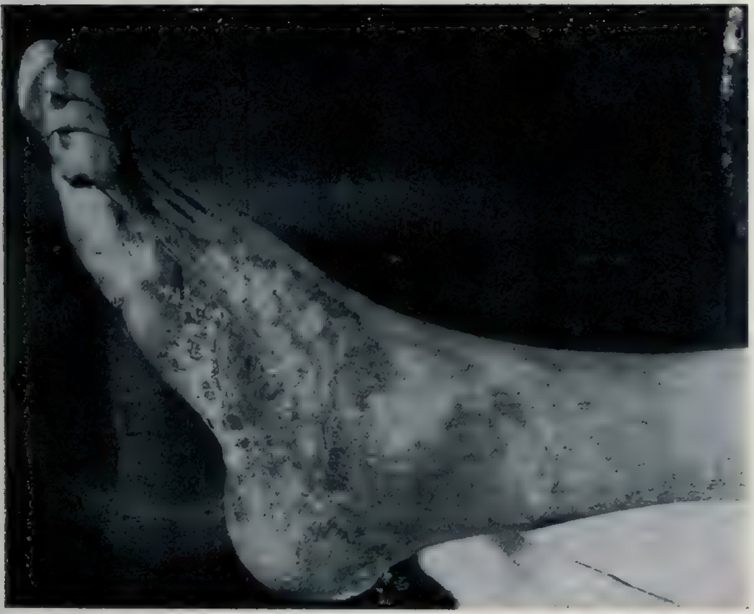

Fig. 173.—Case I. Lateral aspect of site of plastic five years after operation.

thigh for fourteen days, when union was firm enough to cut away the flap. Ultimately an excellent covering was developed for the heel (Figs. 171-176). When the patient was first permitted to step on the foot he was provided with an arch support

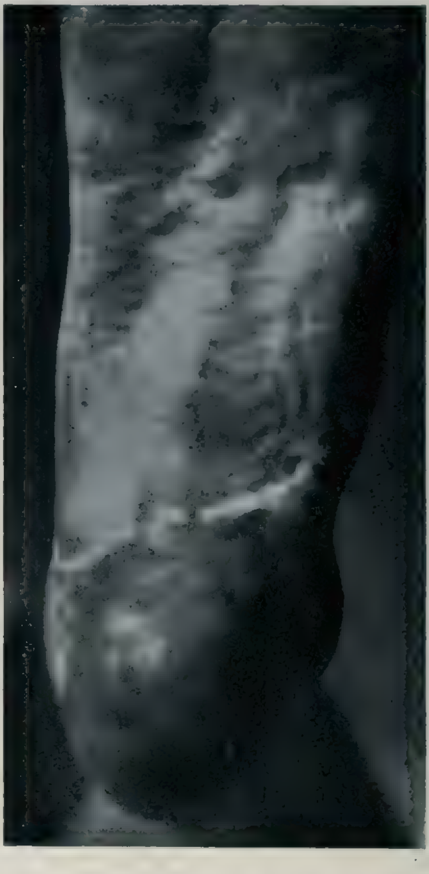

Fig. 174.—Case I. Plantar aspect of site of plastic five years after operation.

which helped to take some of the pressure from the heel. In September, 1915, he was again able to resume his work, and has never been obliged to lay off a day since that time on account of any trouble with his heel.

Gradually the transplanted skin has toughened up to meet the demands of the pressure placed upon it, and he now has a very excellent weight-bearing surface in this transplanted tissue.

It was necessary to place the patient on his face with his leg crossed behind him and hold him in a cast. The discomfiture from this was extreme, and I thought at the time that if occasion ever again arose for a similar operation I should try to avoid keeping him on his face, as the position was difficult for the patient and made it difficult to care for him.

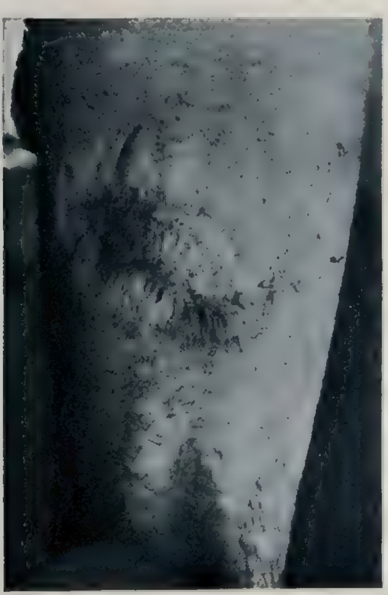

Fig. 175.—Case I. Scar on back of thigh five years after operation. It is supple and does not interfere with function.

In January, 1916, we received another patient who had the right leg crushed off below the knee and crushed off his left heel. The os calcis was cut through about midway between the anterior and posterior ends. The entire padding and soft tissues about the heel were destroyed. The question arose at that time of amputating the foot, but the doctors in charge decided to try to save it. He came under our care some time later, with an ulcer on the heel which could not be covered with skin because

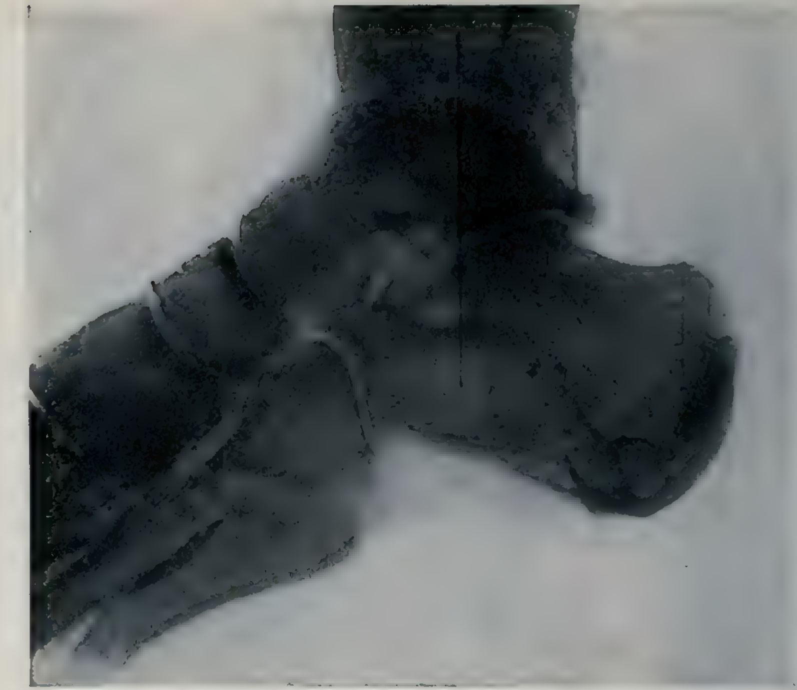

Fig. 176.—Case I. *x*-Ray of heel two years after operation. Note the increased density of the bone at the posterior end of the os calcis persisting as a relic of chronic infection incident to its exposure following the initial trauma.

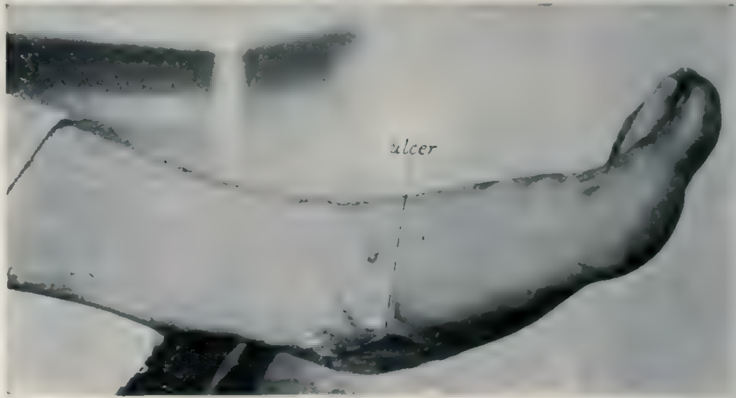

Fig. 177.—Case II. Medial aspect of heel before operation. Note ulcerate areas where previous Thiersch grafts have broken down.

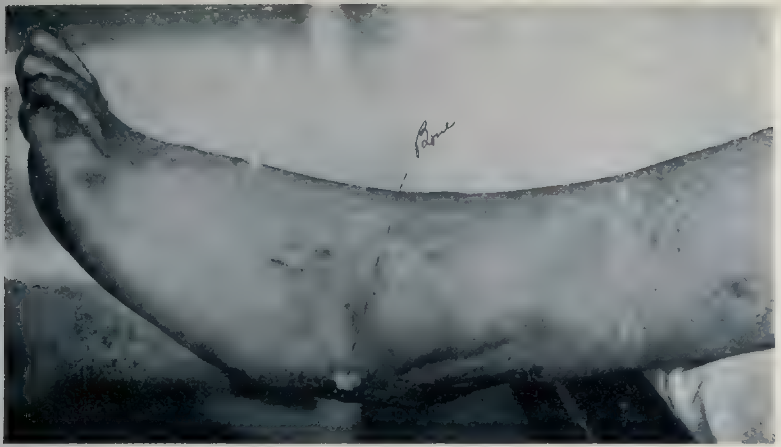

Fig. 178.—Case II. Lateral aspect of heel before operation. Note ulcerate areas where previous Thiersch grafts have broken down.

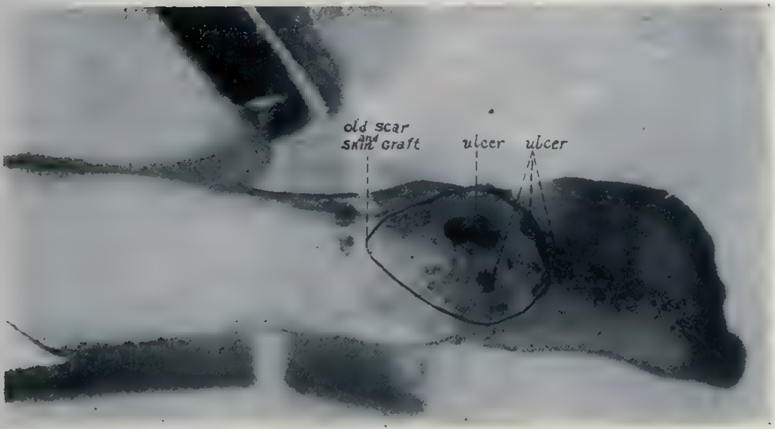

Fig. 179.—Case II. Posterior aspect of heel before operation. Note ulcerate areas where previous Thiersch grafts have broken down.

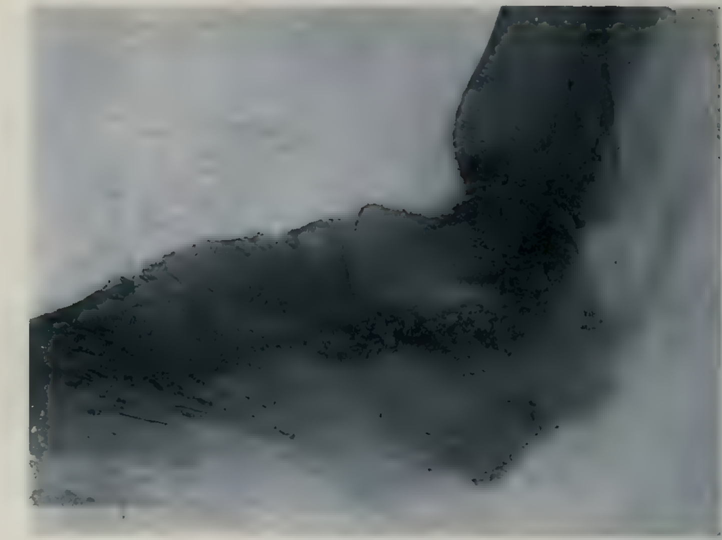

Fig. 180.—Case II. *x*-Ray of foot before operation. Note bony excrescence corresponding to areas of ulceration shown in preceding photographs.

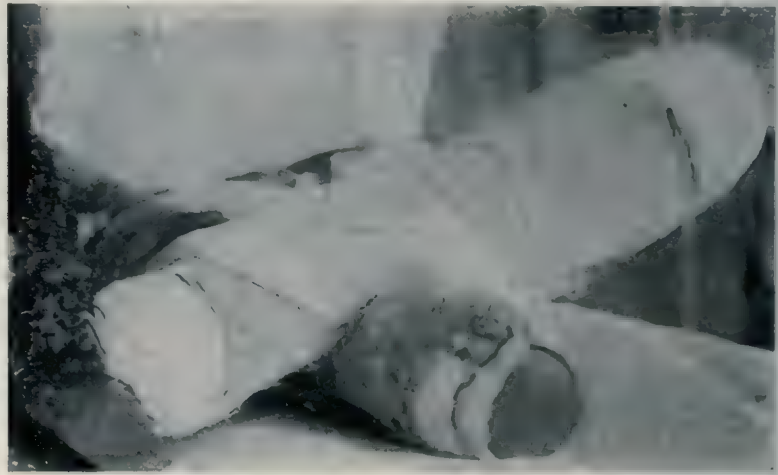

Fig. 181.—Case II. First stage of operation completed; affected foot immobilized on anterior aspect of opposite thigh by plaster cast; skin-flap remains in position without tension.

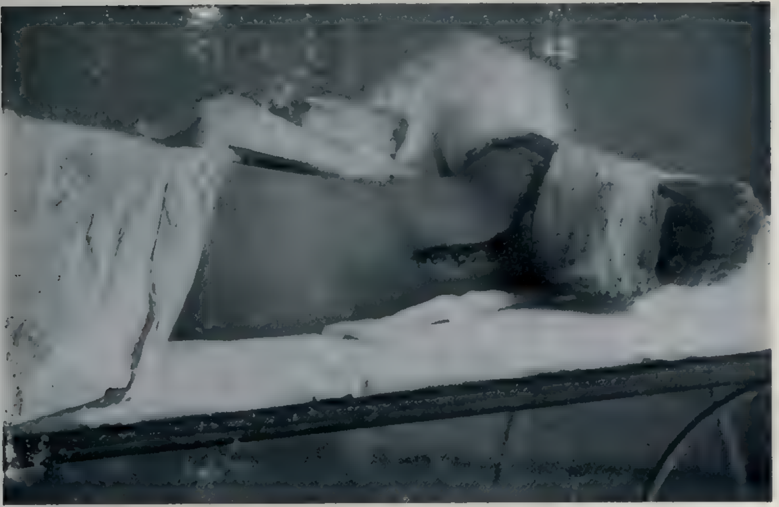

Fig. 182.—Case II. First stage of operation completed; affected foot immobilized on anterior aspect of opposite thigh by plaster cast; skin-flap remains in position without tension.

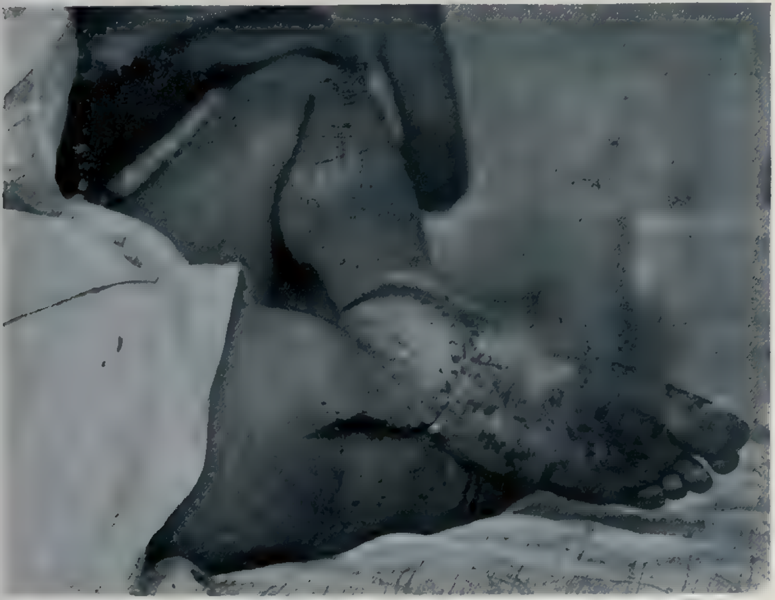

Fig. 183.—Case II. Sixteen days after primary operation; stitches have been removed and flap is about to be freed from the thigh.

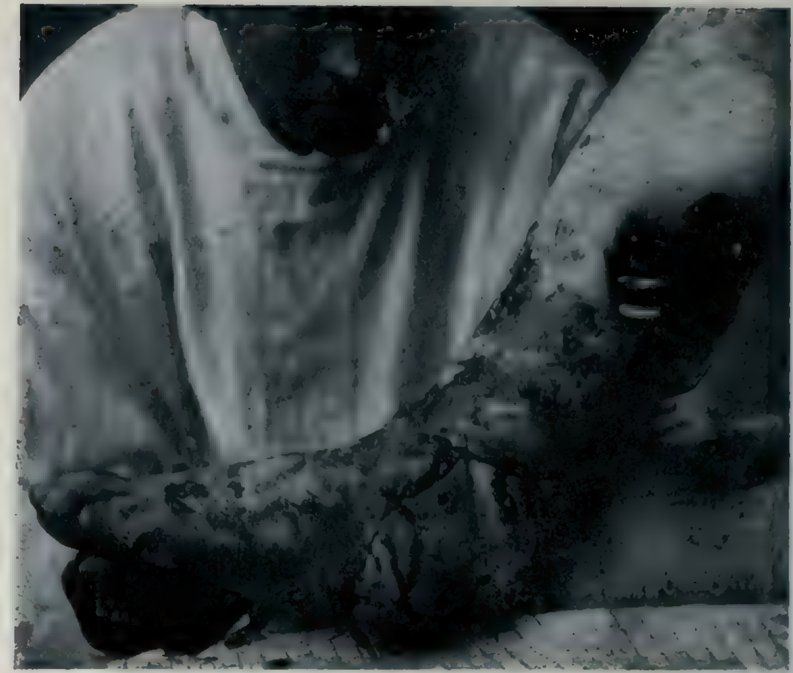

Fig. 184.—Case II. Nearing completion of second stage; flap has been freed from thigh and brought around heel by long tension sutures; coaptation stitches not yet in place.

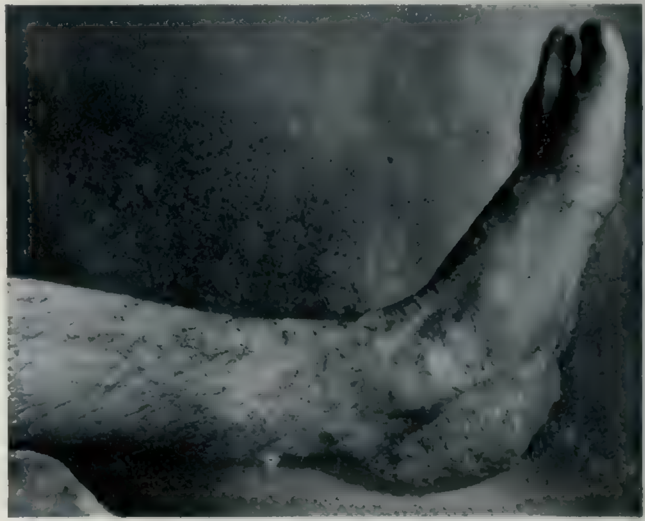

Fig. 185.—Result in Case II eight months after operation

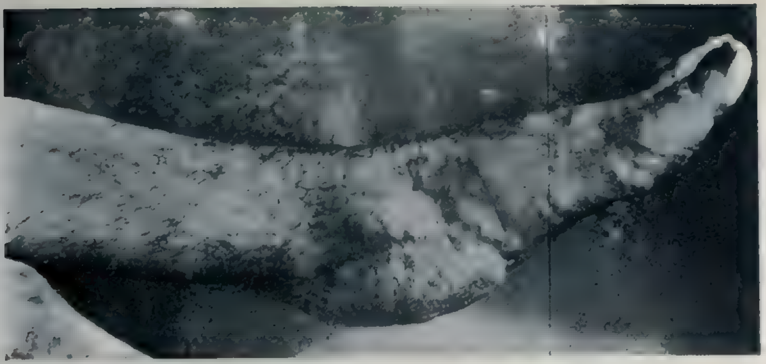

Fig. 186.—Result in Case II eight months after operation.

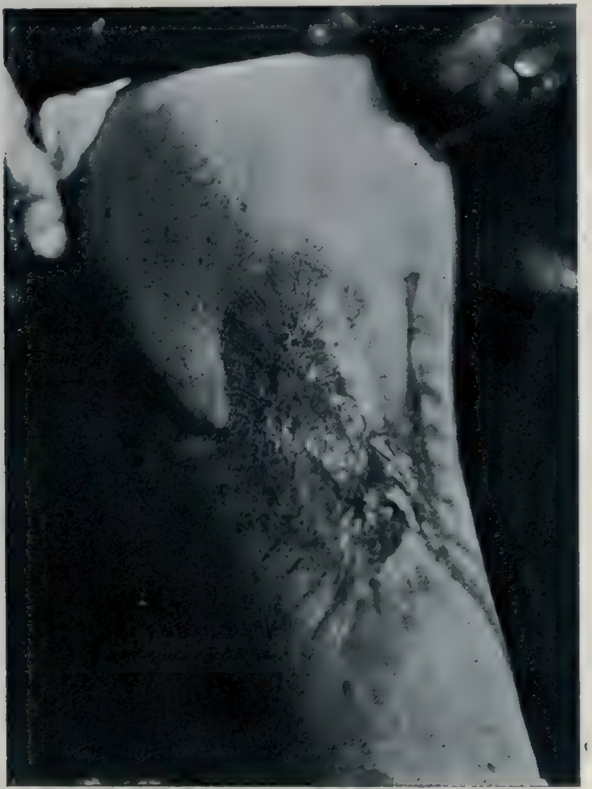

Fig. 187.—Case II. Deep scar on anterior surface of thigh eight months after operation. As this patient had lost the leg below the knee on this limb the scar shown here produced no inconvenience.

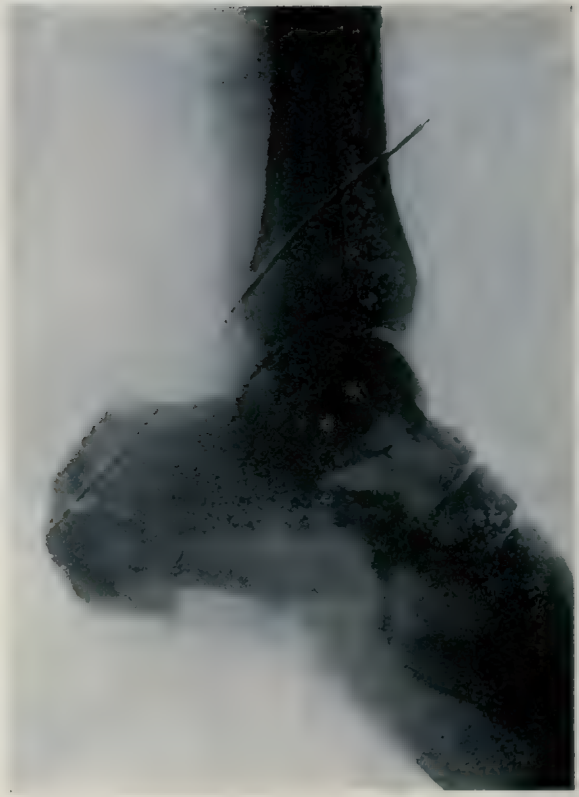

Fig. 188.—Case III. x-Ray of foot before operation. Note changes in os calcis similar to but more marked than those in Case I.

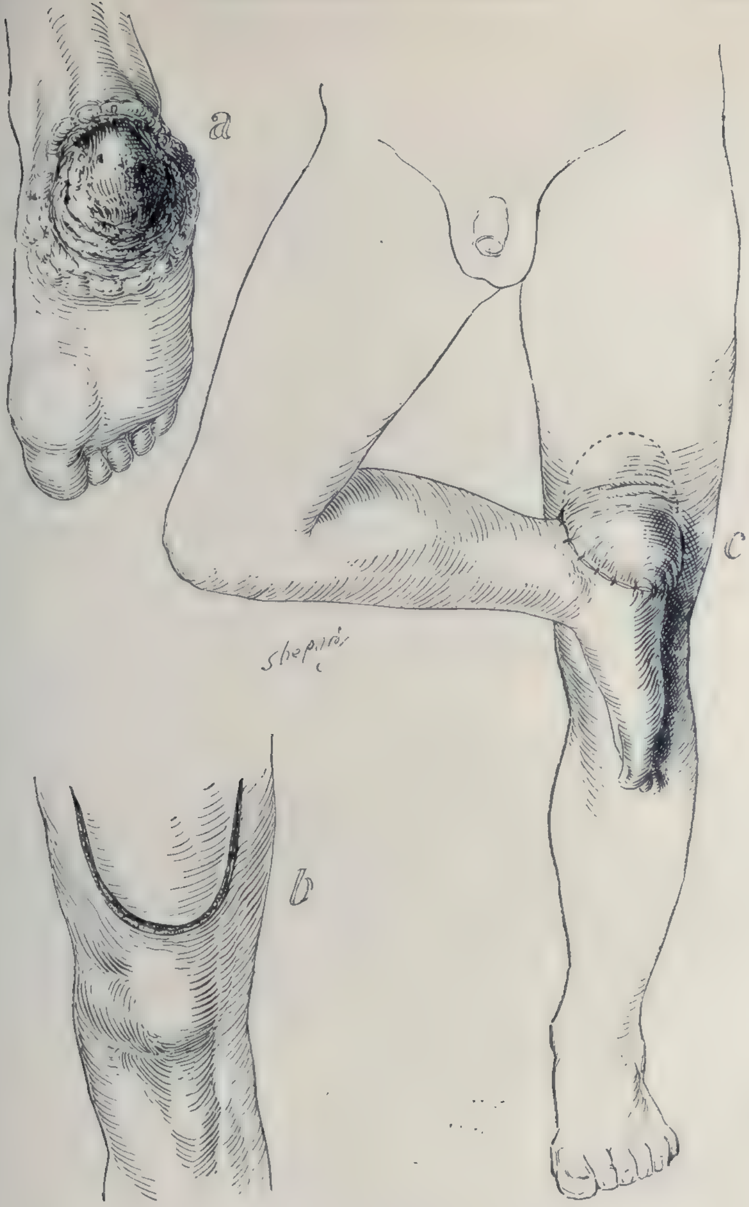

Fig. 189.—Case III. Details of operation: *a*, Defect in heel at beginning of operation; *b*, V-shaped incision on anterior aspect of thigh of opposite leg which outlines flap to be transplanted; *c*, first stage of operation completed; ready for application of cast.

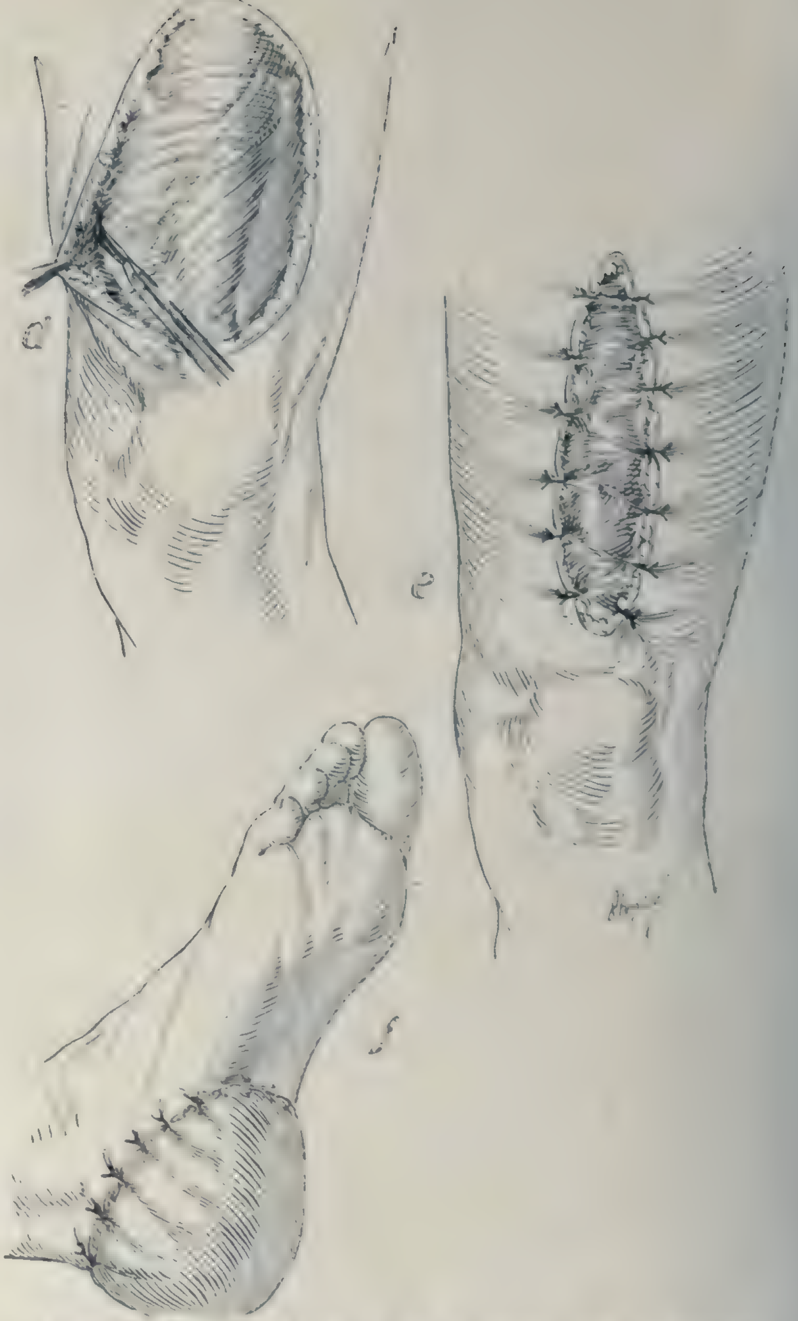

Fig. 190.—Case III. *d* and *e*. End of second stage of operation: pedicle of flap has been cut: the edges of the defect on the thigh are undercut, the skin mobilized and the defect closed as nearly as possible; any uncovered area may be closed by Thiersch grafts; *f*. flap freed and in place on the heel.

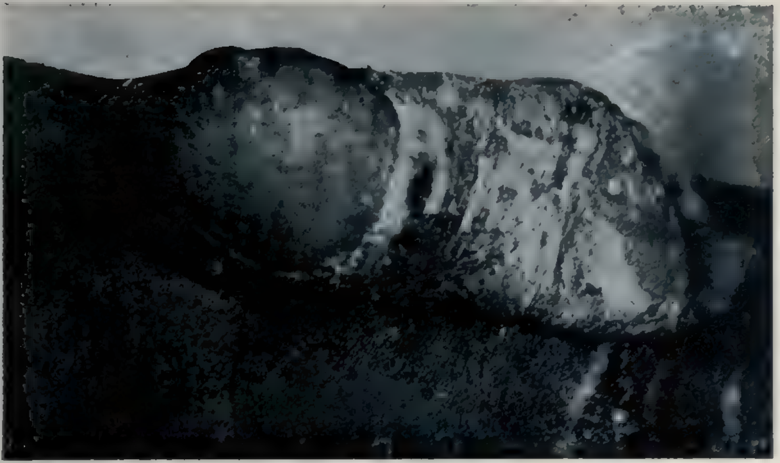

Fig. 191.—Case III. Condition about three months after completion of second stage of operation; flap healed securely in place.

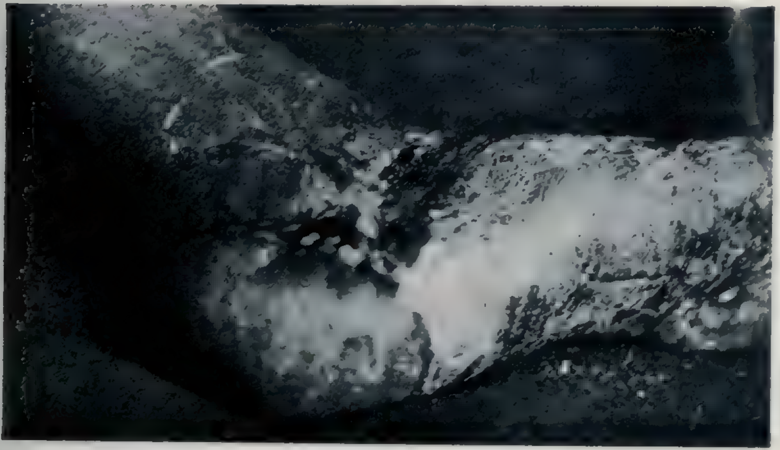

Fig. 192.—Case III. Condition about three months after completion of second stage of operation; flap healed securely in place.

of the dense scar tissue. Two and a half years after his injury he was still unable to use his foot, and was walking with an artificial leg and a pair of crutches. In July, 1918, we performed a flap operation to cover the heel. Hoping to obviate some of the difficulties encountered in the first operation, we sat the patient up and crossed his legs in front of the thigh, holding it in a cast.

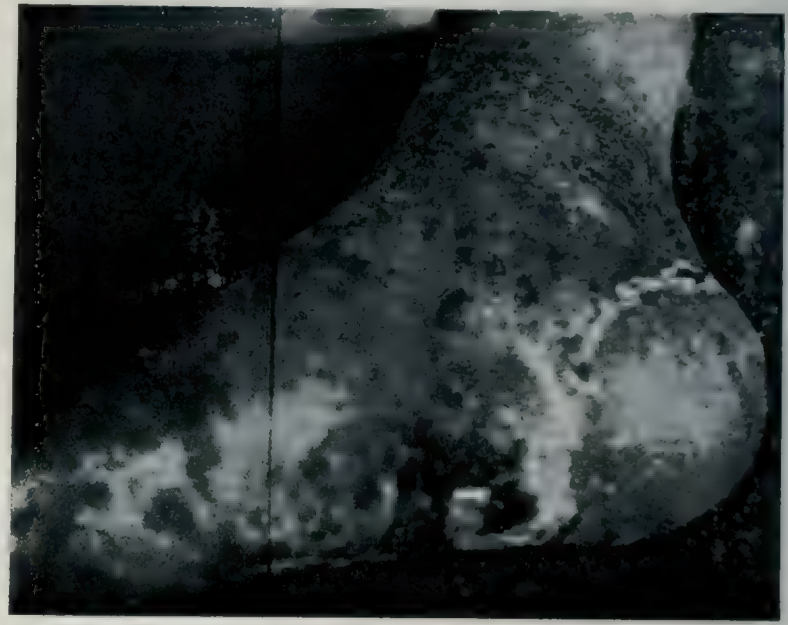

Fig. 193.—Case III. Condition about three months after completion of second stage of operation; flap healed securely in place.

This was a great improvement so far as the position of the patient was concerned, but we found later that the pressure of the external malleolus over the front of the high was so great that it produced necrosis that reached to the femur and necrosed the skin over the external malleolus. It was necessary to take a large amount of flap away in order to cover this defect over the malleolus. Subsequently we skin-grafted the area over the front of the thigh, and there has been a full restoration of the function of the quadriceps muscles and tendons (Figs. 177-187).

About six months after this operation a case was brought to my clinic in Cook County Hospital for a curetment of the os calcis because of a persistent ulcer on the heel. Inquiry into the history showed that the patient had two years previously had the end of his heel crushed off in an accident in Mexico, and though skin-grafts had been applied, an area of about 1 inch in diameter remained as an open ulcer. A radiograph showed that the periosteum over the end of the os calcis had been damaged and had produced a thickening in this region.

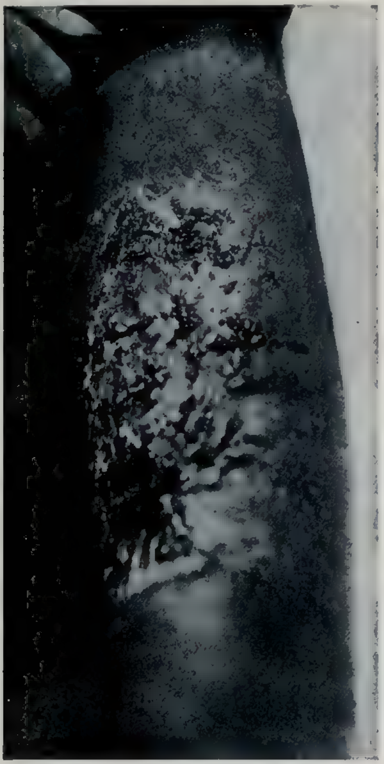

Fig. 194.—Case III. Scar on anterior surface of thigh three months after operation; it has entirely healed, and though there is still considerable interference with the usefulness of the underlying muscles, function is rapidly returning to them.

We decided that the only way to get a serviceable foot was to put a transplant over the denuded area. With our experience of the two previous cases we hoped to make this patient the most comfortable and avoid the sloughing which took place in the second. We turned up he flap from the front of the thigh, but padded well to keep pressure off the external malleolus. We found when ready to cut the flap down that, in spite of all our precaution, necrosis had taken place, as in the second case. Despite this we have secured a degree of healing which now seems certain to give a good functional result (Figs. 188-194.)

No. 17

Reprint from SURGERY, GYNECOLOGY AND OBSTETRICS, December, 1919, pages 592-595

CONGENITAL DEPRESSIONS, SINUSES, AND CYSTS OCCURRING IN THE SACROCOCCYGEAL REGION[1]

BY R. W. McNEALY, M.D., CHICAGO

I PURPOSE in this brief paper to discuss those depressions, sinuses, and cysts which are of congenital origin and are found in the median line of the back over the coccyx or the lower portion of the sacrum. I shall confine my discussion of the cysts to those of simple epithelial lining (simple dermoids).

Wette classifies these conditions according to the degree of the anomaly into: (1) fovea sacrococcygea, (2) fistula sacrococcygea, (3) epidermoid sacrococcygeal cysts. He holds that they are all only varying degrees of the same type of anomaly.

Dèsprès and Lannelongue state that these anomalies are to be found, in some degree, in one-third of all newborn infants, but that by adult life they are found in only 3 per cent of people examined. Since my attention has been called to these conditions I have been impressed by their frequent occurrence, without their ever having been noticed by the patient.

The large majority of cases are found in males. In discussing postanal dimples, Lynch states that all of his 51 cases were males. Griffon and Archibald had only 2 females in their 31 reported cases. I have had only one female in my operative cases, although I have found the condition present in many females in the course of examination.

Most of these cases escape notice until adult life when due either to infection or rapid increase in size, they become troublesome.

The fovea coccygea or simple depression, as a rule, gives rise to very little trouble.

The sacrococcygeal fistulæ may be single or multiple. They may be simple epithelium-lined canals extending from the skin surface to a variable depth in the loose tissue over the sacrum or coccyx. Where infection is present, or has been present, the epithelial lining is replaced by granulations and connective tissue. It is not uncommon to find these fistulæ filled with loose hairs which Hodges maintains are rubbed off of the body and crowded into these fistulous openings. Some of these fistulæ have dilated cysts at their depths which contain loose hair, cholesterin crystals, and the products of skin glands. The presence of hair in these fistulæ and cysts has always attracted considerable attention as well as speculation as to the origin of the hair. These hair-filled fistulæ and cysts are termed pilonidal sinuses and pilonidal cysts respectively.

It is apparent that the fistulæ may be primary or secondary. The secondary fistulæ follow suppuration and discharge of the contents of a cyst. The discharge may find its way through a preformed epithelial tract or it may burrow for some distance through the soft parts before coming to the surface. I had one case in which there were three widely separated fistulous openings. One opening occurred in the mid-line about 1 centimeter from the anus; the other two were about 2 inches above the first and about 1 inch on either side of the median line. The three fistulæ originated from an infected cyst near the tip of the coccyx. The two upper fistulæ were the result of the pus burrowing in the soft tissues; while the lower fistula followed in the tract of a congenital epidermal invagination.

The dermoid cysts of the sacrococcygeal region vary in size and are generally situated immediately beneath the skin, but they are sometimes found deeper near the tip of the coccyx. Wette reports one case where the cyst was found in the spinal canal. As a rule the cysts are adherent to the skin, or connected to it by the apex of an invagination of epidermis. In dissecting out these cysts it is customary to find them connected to the spinal column by fibrous bands. The walls of the cyst vary in thickness, depending upon the amount of connective tissue present. Some of the cysts are lined by stratified squamous epithelium and show hair follicles and rudiments of sweat and sebaceous glands.

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[1] Read before the Chicago Surgical Society, November 15, 1918.

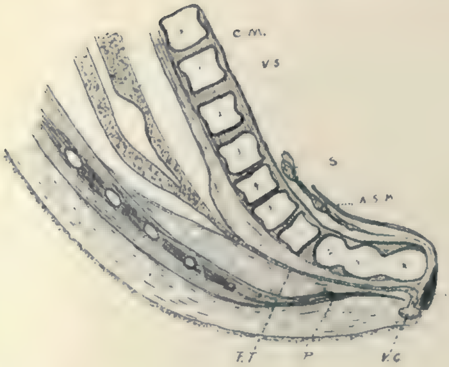

Fig. 1. *C. M.*, Conus medullaris; *V. S.*, vertebra sacralis; *S.*, sympatheticus; *A. S. M.*, arteria sacralis media; *L. C.*, ligamentum caudale; *V. C.*, vestiges coccygiens; *P.*, periosteum; *F. T.*, filum terminale. (After Unger and Burgsch.)

Czyewicz describes a case in a man 23 years of age in which the cyst contained a bunch of hair but there were no hair follicles in the remaining epithelium lining the cyst. In the cases operated upon by me, I have never been able to demonstrate hair follicles in the epithelial linings of the cysts, although several showed bunches of hair.

Many theories have been advanced to explain these fistulæ and cysts.

Mason Warren thinks they arise from the hair growing in an abnormal direction from the follicles, the irritation caused by the hair causing inflammation which results in fistulæ or cysts.

Lawson Tait attributes them to rudimentary tail formation in man.

Kuhn believes they are the remains of a hydrorrachis beginning during intra-uterine life.

Lannelongue believes them to be due to a persistence of a fœtal connection which exists between the external skin and the lining of the medullary canal. The persistence of this connection causes the fistulæ, and when the fistulæ are later constricted, cysts arise. He explains the characteristic localization of the lesions by the fact that the mesodermal masses which produce the separation between the medullary canal and the external skin are less well developed in the coccygeal region than elsewhere. In this way they have less force to loosen this connection during the developmental period. This theory is accepted by Peyramaure-Duverdier and Couroud. Wendelstadt and Wette have a similar theory except they think the site of the fistulæ and cysts is due not to insufficient development of the mesodermal masses but to delayed closing of the medullary canal.

Masse assumes that they owe their origin to the persistence of the medullary tube.

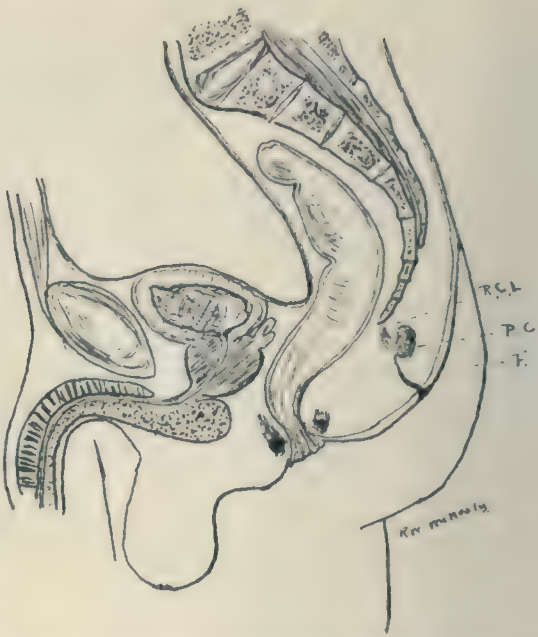

Fig. 2. *F.*, Fistulous tract; *P. C.*, pilonidal cyst; *R. L. C.*, remnant of caudal ligament.

Madelung believes them to result from an abnormal development of the ligamentum caudale.

Mallory made microtome sections through the sacrum and coccyx of various aged embryos. He concluded from his findings that these fistulæ and cysts are due to an incomplete obliteration of a fœtal canal and reasoned that since they all extend upward and posteriorly to the coccyx, the medullary canal seemed the most likely origin.

The theory which is usually accepted at present is the one formulated by Tourneux and Herrmann based upon their interesting work in embryology. The development of the central nervous system by infolding of the primary ectoderm needs no explanation, except to explain certain departures from the uniform development which are peculiar to the caudal end of the spinal cord. The description of these changes I have taken from Keibel and Mall's book on human embryology.

If one examines a sagittal series through an embryo 11 centimeters long (as shown in Figure 1) it can be seen that the extreme tip of the cord lying in the tail anlage has been closed off to form a simple epithelial sac. The lumen of the cord above this point becomes obliterated and there results a slender solid strand of nervous tissue which we know as the

> filum terminale. The epithelial sac becomes the vestige medullaire coccygien of Tourneux and Herrmann, the development of which is described by Tourneux[1] as follows: At the beginning of the third month the neural tube still extends to the extreme end of the vertebral column into the tail bud and its slightly enlarged tip is closely united to the deep layers of the skin. Toward the end of the third month the spinal column, developing faster than the soft parts, draws along the part of the neural tube that is adherent to it and whose extreme tip remains attached to the skin. As a result of this unequal growth the terminal or coccygeal portion of the neural tube becomes bent in the form of a loop, the more deeply situated limb of which is attached to the posterior surface of the coccyx (segment coccygien direct), and the other more superficial limb extends obliquely from a caudal and ventral position to one more dorsal and cranial (segment coccygien réfléchi). During the course of the fourth month the more deeply situated limb, the segment coccygien direct, atrophies and disappears, while the more superficial one, the segment réfléchi, continues to develop into the fifth month and gives origin to cell cords or cell masses which contain cavities lined either with prismatic or pavement epithelium; these are the vestiges medullaires coccygiens or paracoccygiens. These structures from the sixth month on suffer a progressive atrophy, but it is possible to recognize traces of them up to the time of birth.

The simple depressions and the fistulæ are explained by the more rapid growth of the soft parts causing traction of the ligamentum caudale upon the vestiges coccygiens which is intimately attached to the deep layers of the skin.

There are two types of cysts. Cysts of the first type are due to dilatation of the epithelial sacs which constitute the vestiges medullaires coccygiens. Cysts of the second type may occur as a result of dilatation of the deep part of a fistula, or to occlusion of a fistulous tract near its outlet. It is possible that they may be formed by the skin anlage being entirely constricted off from the surface and existing in the soft tissue. This difference in origin of the two types of cysts may explain the variations which are to be found in the microscopical examination of the cyst walls. In cysts of the first type nerve cells are sometimes found in the cyst walls. Various mixed tumors are said also to originate from these vestiges coccygiens, but I have purposely omitted any discussion of these or the dermoids supposed to originate from the hindgut or neurenteric canal.

The treatment of these cases herein described follows the routine technique for similar conditions elsewhere.

The simple depressions, as a rule, give no indications for intervention.

The fistulæ are carefully dissected out and immediate closure made if one is reasonably assured that all the fistulous tract has been removed and no infection is present. If infection is present, it is best to allow tracts to granulate after dissection. I do this in nearly all cases. I have found it advantageous to make a circular incision around the mouth of the fistula and suture it to prevent escape of contents during dissection. Where multiple fistulæ exist, the various ramifications may be shown by injecting Beck's paste and taking a roentgenogram. Lynch recommends the use of methylene blue in peroxide for tracing anal fistulæ and I have employed his method very successfully in these fistulæ. I have also injected iodine into the fistulæ before dissection but do not recommend it.

Some of the cysts are the seat of acute inflammatory changes and must be opened and drained, later following with complete dissection. I had one case come into clinic which had been operated upon four times. Two fistulæ were present at the time of examination. Under general anæsthesia a careful dissection revealed a small cyst containing a ball of hair. The cyst wall was closely attached to the coccyx.

Many of these occluded fistulæ and cysts are diagnosed as furuncles and incised and drained, leaving a chronic discharging sinus. Care must be exercised in not confusing these fistulæ with those of anal, tuberculous, or syphilitic origin. Lynch reports a case in which a degenerating syphilitic focus discharged through a sacrococcygeal fistula and was operated upon several times before its nature was discovered.

In view of the fact that nearly all of my cases had been previously operated upon, I strongly recommend a thorough examination of all fistulæ and cysts occurring in this region. If any trace of epithelial tract is left in these cases a cure cannot be expected.

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[1] Précis d'embryologie humaine, 2d. ed., 1909, pp. 348, 349.

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ACUTE SEPTIC INFECTIONS OF THE FINGERS

BY ARRIE BAMBERGER, B.S., M.D., ASSOCIATE IN SURGERY, MEDICAL DEPARTMENT UNIVERSITY OF ILLINOIS, ATTENDING PHYSICIAN COOK COUNTY HOSPITAL, CHICAGO.

PROBABLY no surgical condition is of more importance and requires more careful treatment than do the acute infections of the fingers. To the workman a loss of function of one or more fingers often means the loss of his occupation and final pauperism. There are numerous classifications of acute infections of the fingers, many of which are ambiguous and cloud the minds of the practitioner as well as the student. The older terms—paronychia, whitlow, and felon—I believe should be discarded, as they do not designate precisely any type of finger infection. The better classification is the pathological one, naming the exact structures of the finger involved: the subcuticular infection, immediately under the epidermis or cuticle; the subcutaneous infection, involving subcutaneous tissue; the tenosynovitis, involving tendon sheaths; and osteomyelitis, involving infection of the bone. One or more of these types of infection may exist, by simple extension of the infection from one structure to the next underlying one.

Etiology.—External trauma of any description—scratches from fish scales and meat bones, and manicuring of nails in which the cuticle is cut too close to the skin—are the frequent causes of septic infections of the fingers. An adjunct cause, if we may so term it, I believe is the indiscriminate use of hydrogen peroxid after an injury; especially so if foreign material has been introduced into the wound. The first step that usually the layman takes, and indeed many physicians, in cleaning a wound of the finger is to wash that wound thoroughly with hydrogen peroxid. From the many cases of infections of the fingers which I have seen following the use of hydrogen peroxid in the fresh wound, I feel firmly convinced that the gaseous oxygen liberated by the peroxid in the wound forces the bacteria into the healthy as well as into the injured tissues, and thus produces infection which otherwise would not have occurred.

Symptoms.—All of the types of acute septic infection of the fingers produce pain in the affected part, and more or less swelling. The subcuticular type of infection manifests itself by a bleb-like formation, which contains a serosanguinous fluid; the pain and tenderness is slight. In the subcutaneous type, which is most frequent, we find the involved area markedly swollen, red, tender, and fluctuating if pus is present; lymphangitis and neighboring lymphadenitis are frequently present, especially in the streptococcic infections and in those in which there is no free drainage. In tenosynovitis there is severe deep tenderness over the sheath of the tendon involved, and the patient does not move the finger because of the great amount of pain on the slightest movement of the tendon. In osteomyelitis of the phalanges and septic arthritis of the interphalangeal joints there is a very hard and large swelling, much greater than in any of the other types of infection. The tenderness and swelling is deep—that is, it does not involve the subcutaneous tissue alone, but involves the deeper structures. Usually, in a subcutaneous type of infection, when the swelling does not subside within seven to ten days, but remains stationary or increases, we are then dealing with a bone infection. When the osteomyelitis begins, there is a great deal of pain, which subsides after four to seven days, but the swelling persists and pus continues to drain from the wound. An x-ray picture will show the necrotic bone.

Treatment.—Prophylaxis is most important. In an injury of the finger the foreign material, if present, should be removed. The tissue adjacent to the wound, but not the wound itself, should be washed with green soap and water. The wound itself should be first lightly touched with a pledget of cotton soaked in bichlorid of mercury, solution 1:5000 dilution (no rubbing should be done), and then swabbed with tincture of iodin. A hot boric acid dressing is then applied, which should be renewed in twelve hours, and so continued until the wound shows signs of healing, when a dry dressing is applied if no infection is present.

Active Treatment.—In all types of finger infections where pus is present, incise and drain the part. The incision should be a large one and a crucial incision; the longest part of the incision is made in the longitudinal direction, while short transverse incisions are made through the skin only in order to keep the wound from closing too rapidly. A probe is passed into the wound, so that any pockets can be located and opened up along the course of the probe. When a tenosynovitis is present, the infected sheaths are opened up and drained. When an osteomyelitis is present, after the x-ray shows the necrotic bone well demarcated, under gas anesthesia the necrotic bone is removed and the fistulous tract curetted. I do not believe in temporizing in these cases, waiting for the bone to slough off by itself. If this latter method is used, I find that more bone becomes involved, and a much longer time is consumed for the recovery of the patient. For drainage I use sterile gutta-percha tissue folded into small strips, which is much superior to the gauze drains, which become dry and stiff from the secretions of the wound, and then act as a plug in the wound rather than a drain. The gutta-percha is smooth, non-irritating, keeps the edges of the wound apart, and in no way plugs up drainage as does gauze. Hot boric dressings are used, and it is important to use enough gauze in making the dressing—not two or three layers of gauze, but ten to twenty. A window is cut in the bandage, so that hot boric acid solution can be poured into the dressing every hour, and the entire dressing is changed every twenty-four hours.

Summary.—The points to be emphasized are:

1. Hydrogen peroxid should not be used as a first-aid cleansing measure; the oxygen liberated forces infection into the tissues.

2. Early diagnosis of osteomyelitis and early excision of necrotic bone are important.

3. Large incisions are called for in all infections of the fingers.

4. The use of gutta-percha tissue as drainage material instead of gauze is advisable.

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TRAUMATIC ASPHYXIA, RUPTURE OF LUNG, DISLOCATION OF CLAVICLE; PYONEPHROSIS, URETERAL STONE; HYPOSPADIAS

BY CHARLES DAVISON, A.M., M.D.

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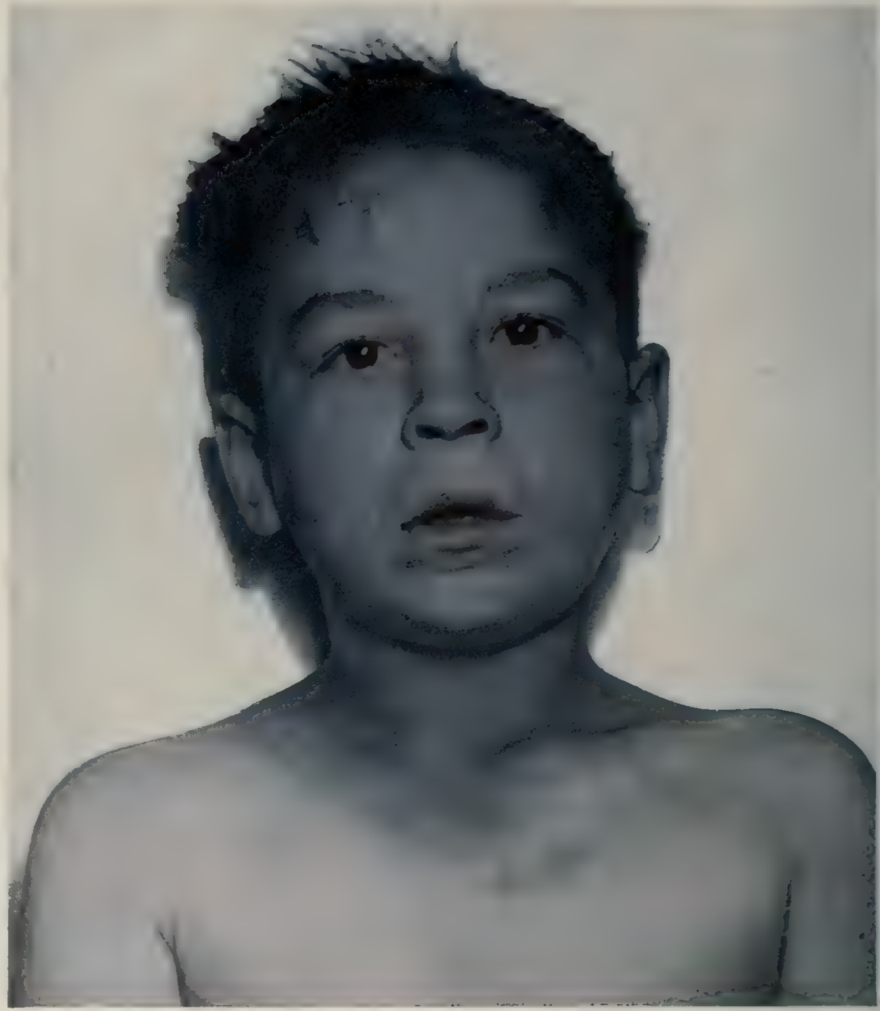
FIG. 1.



Case I. Photograph showing the conjunctival ecchymoses and peculiar discoloration of face, lips, and neck, which follow forcible compression of the chest with inhibition for several minutes. Page 10.

TRAUMATIC ASPHYXIA, RUPTURE OF LUNG, DISLOCATION OF CLAVICLE; PYONEPHROSIS, URETERAL STONE; HYPOSPADIAS

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TRAUMATIC ASPHYXIA, RUPTURE OF LUNG, DISLOCATION OF CLAVICLE

This patient is a boy of twelve years of age, who sustained severe injuries in an automobile accident. He was playing ball in the street and ran, head on, into the radiator of a moving automobile. He was picked up and brought into the hospital at once. An immediate physical examination developed the following conditions:

1. Shock. The child was almost in extremis. He was gasping for breath. His respirations were weak, shallow and rapid. His pulse was irregular and almost imperceptable. His skin was bathed with cold, clammy perspiration.

2. Dyspnœa. His efforts at breathing were frantic and irregular. Decubitus was impossible. He had to be kept constantly in the sitting position or he would stop breathing. The frequent use of oxygen apparently prevented immediate death.

3. Cyanosis. A marked bluish discoloration of the skin, limited to the scalp, face, lips and neck was present. It disappeared in four or five days (Frontispiece).

4. Conjunctival ecchymoses. Both eyes showed marked ecchymoses (Frontispiece).

5. Expectoration. There was a marked expectoration of frothy, blood-stained sputa. There was a constant, distressing, hacking cough.

6. Cellular emphysema was present over the neck and chest. It became limited in a few hours and disappeared in four or five days.

7. Collapse of lung. Examination of the right side of the chest by inspection, percussion and auscultation indicated collapse of the right lung. There seemed to be no movement of the right chest wall

during attempts at respiration. Percussion gave a tympanitic sound over the right side, except at the lowest part, which showed a limited dull area. There were no respiratory sounds to be heard with the stethoscope on that side of the chest. Examination of the left side of the chest indicated partial collapse of the left lung. There was very slight movement of the left chest wall during attempts at respiration. The upper part of the chest was tympanitic but the lower part was dull on percussion. Auscultation developed a few coarse râles in the bronchial tubes but no vesicular sounds were audible.

8. Dislocation forward of the sternal end of the left clavicle.

9. Bruises about the head and chest. There was no apparent injury to the abdomen or other parts of the body.

The boy was propped in the sitting position with ice packed around the neck and upper part of the chest for six days. Oxygen was administered in five minute periods every thirty minutes for five days and when needed for five days more. Oxygen gave so much relief that the child would cry for more to be given. The immediate use of oxygen in carefully graduated amounts probably saved the patient's life. The cough was distressing for a few days. Bloody expectorations lasted for about one week.

On the sixth day his condition was much improved; temperature, 99.6; pulse, 112; respiration, 40, with fair respiratory expansion of the thorax and fair respiratory murmur upon the left side, but limited upon the right side.

A röntgenogram was taken upon the sixth day (Fig. 2).

No treatment was given the dislocated clavicle, because of his condition at first and later because reduction seemed impossible without an anæsthetic, and any general anæsthetic was considered contraindicated on account of the injured lungs.

The resulting deformity is slight and does not interfere with function.

A röntgenogram taken on the twenty-seventh day shows almost complete expansion of the injured lungs (Fig. 3).

His recovery seems practically complete at the end of four weeks.

It is very unusual for a victim of traumatic asphyxia to recover, because of the sudden complete interruption of the respiratory function which cannot continue any great length of time without death.

Traumatism, like the rolling and squeezing by crowds or compression by machinery, usually continues beyond the time of resuscitation.

If the patient could be quickly released from the pressure and be given proper surgical aid at once, life might be preserved in many cases, but from the nature of the circumstances surrounding the injury efficient surgical aid could only be a rare coincident.

In this case the compression was of short duration, the patient was quickly carried into a hospital, where oxygen and efficient surgical aid were given at once.

SUMMARY

Traumatic Asphyxia.—This rare and striking discoloration of the face and neck, with conjunctival ecchymoses, accompanied by serious dyspnœa, following a compression injury of the thorax, are the four diagnostic symptoms of *traumatic asphyxia.*

Rupture of Lung.—Collapse of lung, extensive cellular emphysema, expectoration of frothy blood-stained sputa, following a serious compression injury of the thorax, indicate compression rupture of the lungs; unless physical or röntgenological examination shows rib fracture, when the lung injury may be due to penetration of the lung or pleura by the fractured rib.

Dislocation of the Clavicle.—This is definitely identified by physical and röntgenological examinations.

PYONEPHROSIS, URETERAL STONE

This woman, thirty-one years of age, a housewife by occupation, has been in poor health for a long time. She has a history of recurrent attacks of abdominal pain, lasting for three or four days, occurring over a period of several years.

Her appendix was removed one year ago, but without relief from the attacks of abdominal pain.

The initial symptoms of this attack occurred thirty-six hours before admission to the hospital. She suffered with severe, sharp, paroxysmal abdominal pains. The point of greatest severity of the pain was to the right of the umbilicus, and it radiated downward into the right thigh. Vomiting began immediately after the inset of pain and persisted until after she entered the hospital.

Examination at the time of admission to the hospital showed a woman acutely ill, practically in collapse, suffering from paroxysmal abdominal pain and vomiting.

Her urine was strongly acid (125°) and contained a few granular casts and some pus cells but no blood. Her leukocytosis was 22,500.

There was a tender palpable tumor in the abdomen to the right of the umbilicus. To differentiate between a tumor caused by an infected distended gall-bladder and a pyonephrosis of the right kidney, the colon was gently distended with air through a catheter in the rectum. If it were a distended gall-bladder the inflated colon would be below the tumor, but if it were a pyonephrosis the inflated colon would be directly in front of the tumor.

The inflated colon showed in front of the tumor, which was diagnostic of a kidney tumor. A röntgenogram showed an enlarged kidney without stones. A röntgenogram of the pelvis shows an oblong stone either in the bladder or in the ureter immediately behind it (Fig. 4).

Upon these findings the diagnosis of pyonephrosis of the right kidney was made.

The patient was operated upon a few hours after admission to the hospital. The right kidney was incised and drained. A small quantity of fetid pus was evacuated.

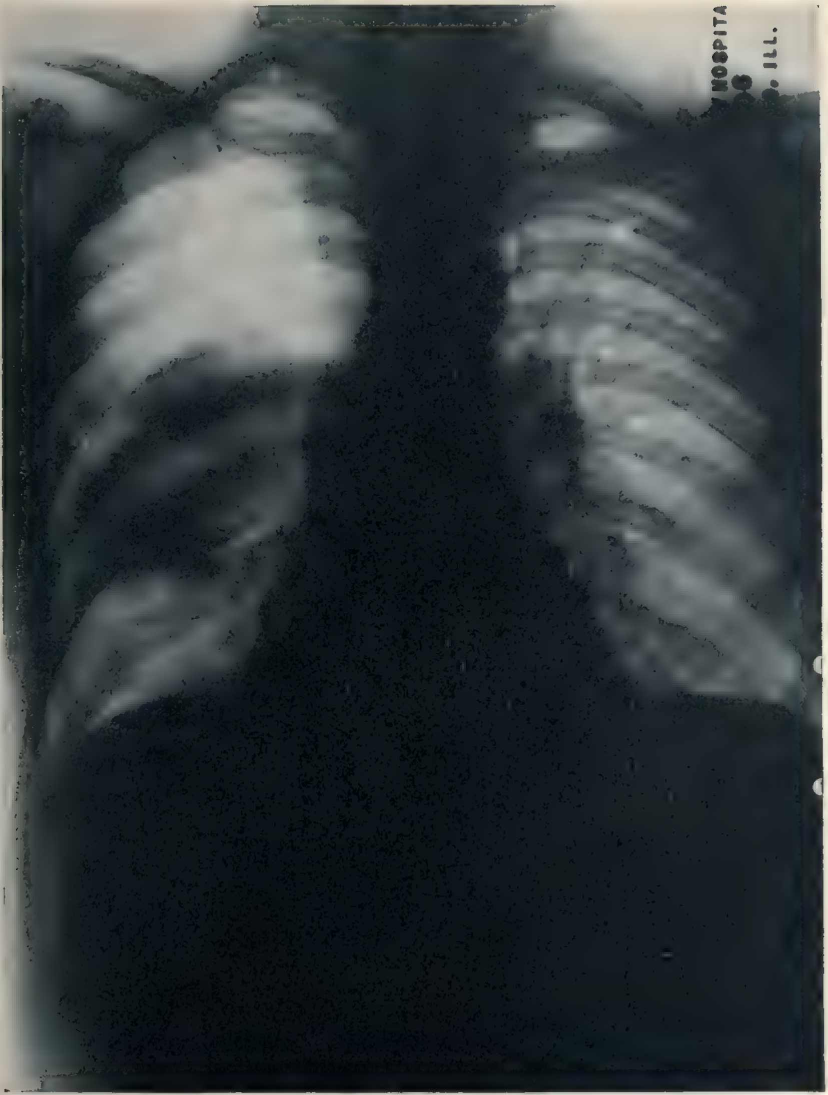
Without further operative procedure the patient was allowed to recuperate from the sepsis for about three weeks, until the urine discharging from the sinus in the right kidney was fairly free from pus. Apparently all of the urine from that kidney was being evacuated through the sinus.

The course of the infection, the quantity of urine discharged through the sinus, the shape and size of the stone shown in the röntgenogram (Fig. 4.) together with its position, apparently posterior to and not in the bladder, indicated obstruction of the ureter by a ureteral calculus.

To demonstrate the location of the stone, a cystoscopic examination was made, the right ureter catheterized and a röntgenogram with the opaque catheter in position taken.

A No. 24 F. cystoscope was passed without obstruction. The bladder was found tolerant to instrumentation. The vesical walls

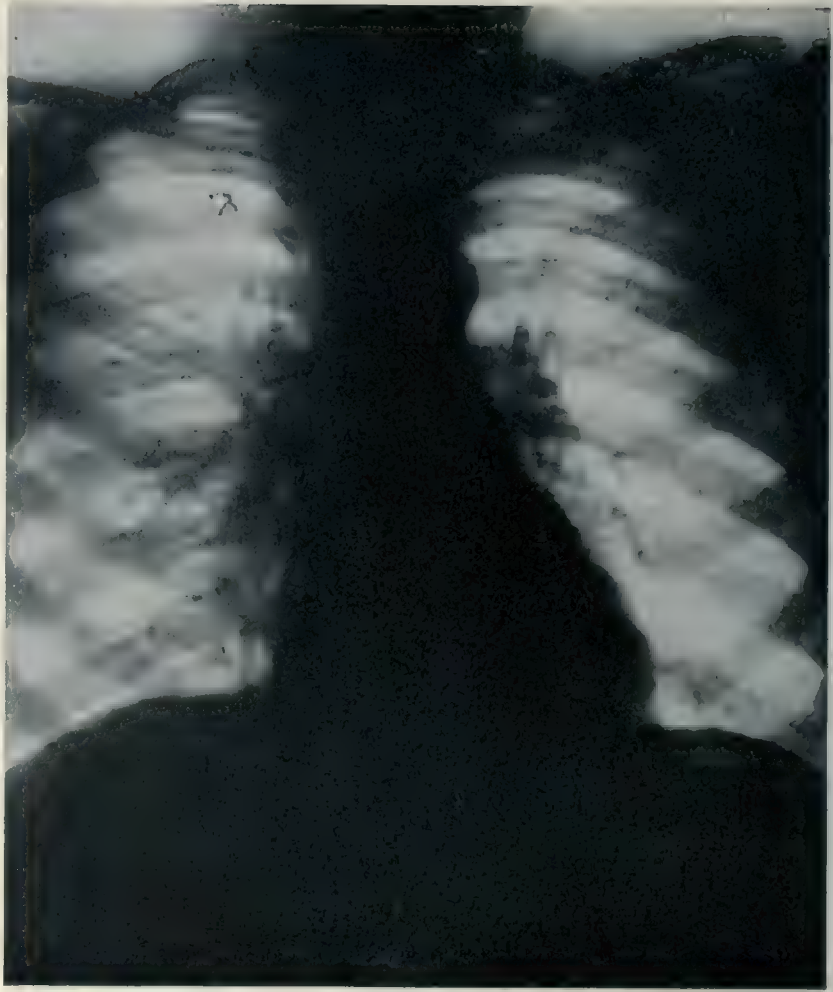
FIG. 2.



Case I. Röntgenogram of chest taken upon sixth day after injury. The right pulmonic field shows evidence of collapsed lung from the level of the second rib in the mid-clavicular line, seventh rib in axillary line and the sixth rib in the mid-scapular line upwards. There is marked increase in density just below the above-indicated levels, suggesting extravasated blood. The domes of the diaphragm are clear cut and smooth. The right appears to be pushed down further than usual as compared with left.

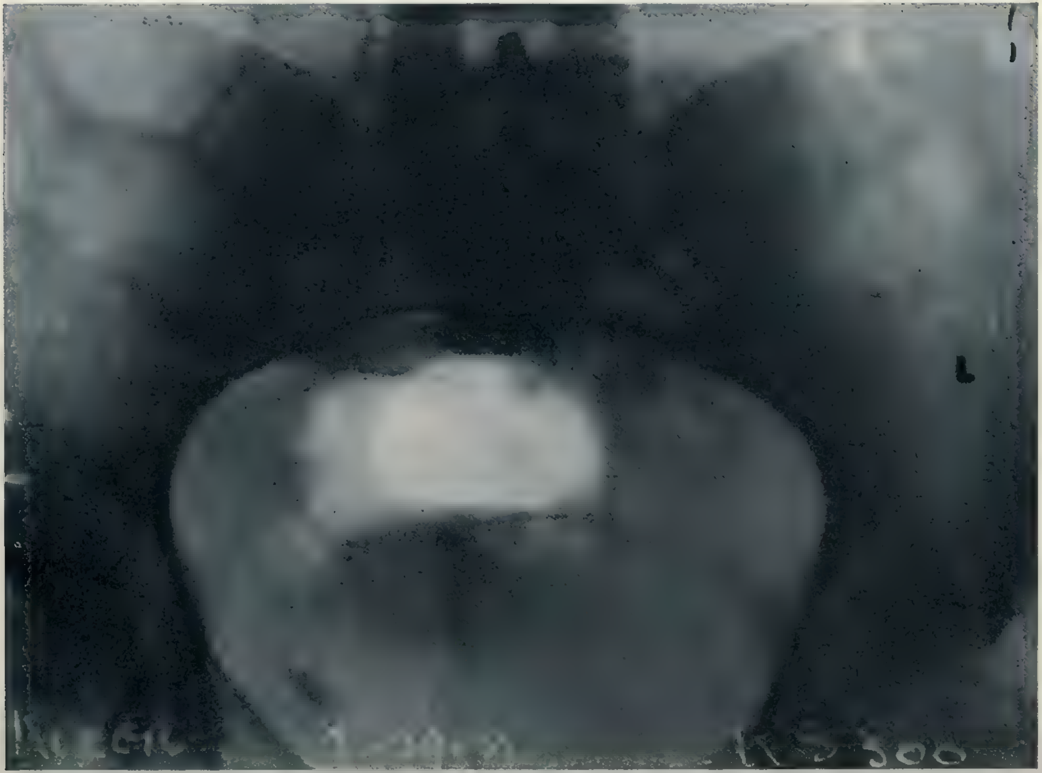
Summary of Röntgenograms. 1. Collapsed lung. 2. Extravasation of blood, right side. 3. Emphysema, right side.

FIG. 3.



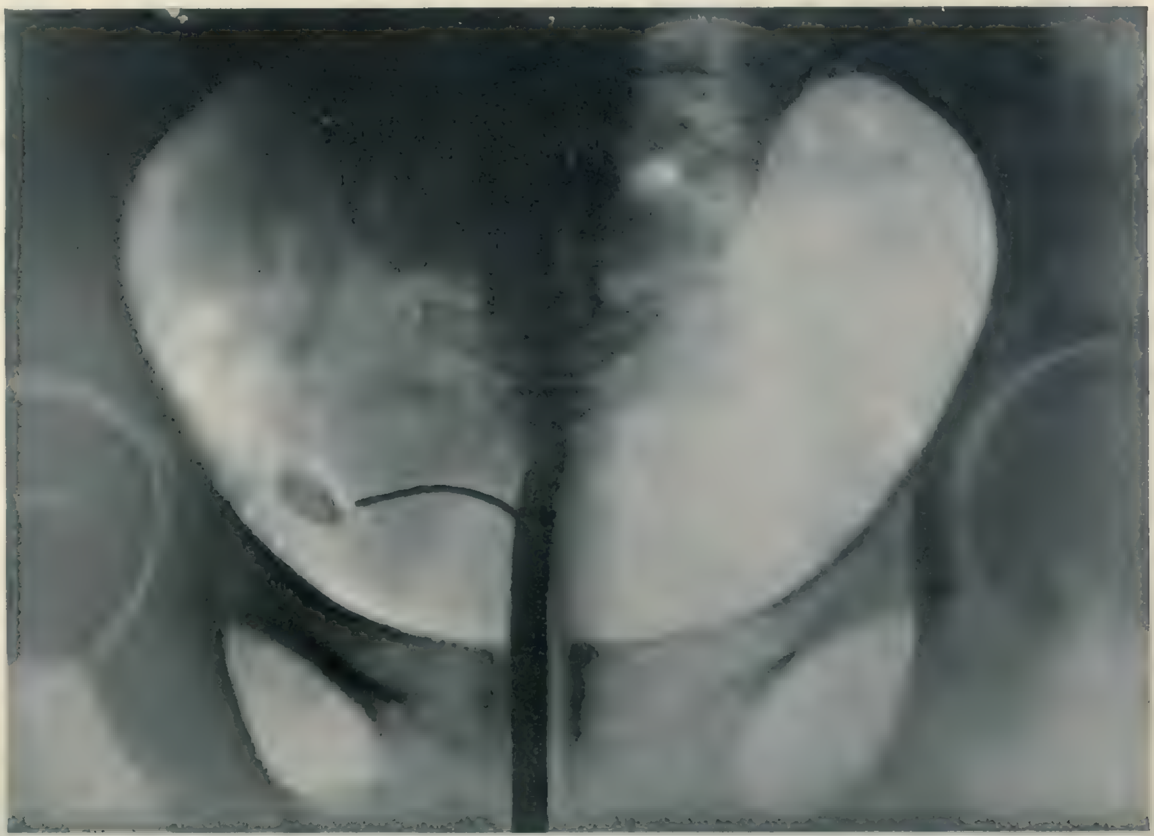
Case I. Röntgenogram of chest taken on the twentieth day after injury. No evidence of collapsed lung on right side. The dense shadow, suggesting extravasated blood, has disappeared. Pulmonary parenchyma can be noted in all portions of upper right side extending into apex. There is a line of thickened pleura extending from the right hilum downward and outward almost to the periphery.

Fig. 4.



Case II. Röntgenogram of the lower urinary tract, showing shadow of an oblong stone and smaller round one above it

FIG. 5.



Case II. Rontgenogram showing opaque catheter in right ureter almost in contact with stone. The stone appears to be practically in the same axis as the catheter. The shape and position of the larger shadow are characteristic of a ureteral stone.

were everywhere slightly congested. The mucosa seemed somewhat thickened. No vesical stones were present.

The right ureteral orifice was surrounded by an area of inflammatory changes and marked œdema. The ureteral orifice was sunken in a pocket surrounded by the œdema. The orifice itself was somewhat patulous and pouting. There was a small flake of muco-pus attached to the wall at that point, which was easily displaced by irrigation.

This picture is practically pathognomonic of a ureteral stone lying near the orifice. The left ureteral orifice appeared practically normal.

Catheterization of the right ureter with a No. 5 F. opaque catheter met with definite obstruction, which could not be passed, at a point 3 to 4 cm. from the ureteral orifice.

A röntgenogram taken with the catheter in position in the ureter shows the top of the catheter in contact with the lower end of the stone (Fig. 5).

With the röntgenogram as a guide, the stone was located by bimanual examination in the broad ligament posterior to the bladder.

The stone was removed by operation through the vagina. An incision was made through the vault of the vagina, posterior to the cervix. The tissues were separated by finger dissection until the ureter containing the stone was located. It was carefully brought down into the vaginal incision and held in position, while the ureter was opened by a longitudinal incision over the stone. The calculus was then easily removed. The wound was left open for drainage, but there was no infection and no discharge of pus or urine.

To prevent stricture of the ureter at the site of operation, a longitudinal incision was made in removing the stone. There has undoubtedly been some injury to the walls of the ureter by the stone while it was imbedded in the ureter, with consequent cicatrization and contraction of the size of the ureter at that point.

The after-treatment in this case, to prevent stricture, consists in the catheterization and dilatation of the ureter at regular intervals.

In the röntgenogram (Fig. 4) there appears a small, round, opaque body not far from the ureteral calculus, suggesting another ureteral stone, but this is not the same shape or position of a ureteral stone. It is round not oblong and not in the line of the ureter.

At the operation it was removed and found to be a phlebolith, probably from the pampiniform plexus.

HYPOSPADIAS

This little boy, three years of age, was operated for the penile form of hypospadias, eight days ago.

It is difficult to get good results with any form of operation for the relief of hypospadias in a young child.

The elements of difficulty are largely due to four things:

1. Urine soiling the field of operation during the period of healing.
2. Tension of the transplanted tissue, from strained position, deficient tissue, improper suturing or post-operative swelling.
3. Normal erection of the penis.
4. Post-operative interference with the repair by the child.

In this case the urine was side-tracked by a perineal, longitudinal urethrotomy, into which a catheter was secured. A curtain of oiled silk was placed between the catheter and the field of operation.

The boy had a large pendulous foreskin which was utilized as a transplant to form the new urethra. Sufficient skin was loosened from the foreskin to form the new part of the urethra. The flap was reversed and sutured with fine catgut so that a tube was made with the epithelium on the inside and the raw surface on the outside. The tube was made twice the size that was apparently necessary to give room for contraction. A large broad pedicle was allowed to remain attached to the prepuce to preserve the blood supply. The curvature of the penis was relieved by free dissection of the adhesions and bands producing it. A bed for the new urethra was made by lateral dissection of skin flaps from either side of the mid-line. The end of the urethra was dissected from its adhesions and its edges freshened so that it would unite with the tube of skin transplanted from the prepuce. The glans penis was perforated at the point where the meatus should be and the tube already prepared from the foreskin was pulled through and sutured to the end of the urethra. The lateral skin flaps were sutured to each other over the tube, with horse hair, without tension. The edges at the junction of the prepuce and glans were carefully denuded and sutured together to form the new frænum.

Since the operation we have tried to keep the wound dry and clean. The patient has been given bromides to prevent erections. His elbows have been fixed to prevent interference with the wound or dressings by himself.

The wound is yet clean and dry and the plastic work seems to be progressing favorably.

In another week the pedicle will be cut across and that part which is to form the edges of the new meatus will be trimmed to fit and sutured to the glans.

If failure occurs in any part of the plastic work, that part must be repeated until success has been attained, regardless of the time involved.

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Th. 3. A.

Treatment of Ununited Fractures of the Neck of the Femur by Bone Transplants

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TREATMENT OF UNUNITED FRACTURES OF THE NECK OF THE FEMUR BY BONE TRANSPLANTS *

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Autoplastic transplantation of bone, combined with external immobilization, is generally accepted by experienced surgeons as the line of treatment most likely to produce osseous repair in ununited fracture of any bone.

It is unfortunate, so far as treatment is concerned, that so large a proportion of ununited fractures of the neck of the femur occur during the late years of life, at a time when operative interference is contraindicated, because of the danger to life from operative shock, prolonged immobilization and decubitus.

If the patient is a wage earner by his physical efforts, in good general health, in the productive time of life, it is a surgical problem for those responsible for his treatment to restore his self-sustaining ability and working capacity as an industrial unit at the earliest time consistent with safety to life.

Transplantation of bone is the indicated treatment for this type of patients.

The rigid adherence to the technical details which make bone-grafting successful, and to a definite plan of operation for the repair of this special ununited fracture, is necessary to obtain favorable results.

A segment of the fibula is best utilized for the transplant. It combines an ideal size and shape, together with the strength, elasticity and lightness of a tube. After the periosteum is removed, it presents a continuous, irregular surface of cortical bone covered

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* Read before the Section on Orthopedic Surgery at the Seventy-Second Annual Session of the American Medical Association, Boston, June, 1921.

by the cambrium layer, which is rich in growing bone cells, available for grafting and osteogenesis. The transplant is obtained from the same extremity unless there is definite osteoporosis.

The ununited fracture is exposed through an anterior incision directly over the defect in the neck of the femur. Removal of fibrous tissue from the area between the fragments is indicated only when it is necessary to free the capital fragment to obtain better position for it. Fibrous tissue that can be preserved without detriment to position of the fragments will undoubtedly act as a framework for the deposition of new bone cells, and hasten rather than retard the formation of substantial osseous union between the fragments after transplantation.

It is not practical to maintain mechanical extension of the extremity while the transplant is being inserted. The neck of the femur has already been partially destroyed and absorbed by the process of grinding together of the fragments by muscular action, and the extremity is permanently shortened in proportion to this destruction of bone. The muscles of the thigh are contracted to correspond to the bone defect.

If the transplant were inserted during mechanical extension, it would immediately be put under cross-breaking strain, equivalent to the amount of mechanical extension as soon as the extremity was released from traction. Under such a strain the transplant will either break at the fracture or cut through one of the fragments until the tension is relieved.

The transplant should be inserted while the thigh is in complete abduction, as that position, without traction, increases the length of the extremity, by changing the angulation of the fragments (Figs. 1 and 2).

For the introduction of the transplant, a second incision is made along the outer aspect of the thigh, exposing the shaft of the femur immediately below the greater trochanter, where an opening through the cortical bone of the outer part of the shaft is made accurately fitting the irregularities of the large end of the transplant. With the capital fragment held in proper position, a canal, smaller than the transplant, is cut through to the articular cartilage of the head of the femur. The transplant is driven into this canal, across the line of fracture, until the end rests against the under surface of the cartilage of the capital fragment (Fig. 2).

To obtain union between the transplant and the fragments, it is imperative that all motion between them be prevented. Intermittent muscular spasm of the muscles attached to the trochanters, acting on the transplant, will cause it to break or to cut its way through one of the fragments to relieve the strain. Complete abduction of the thigh will cause the muscles attached to the lesser trochanter to pull the fragments solidly together in the long axis of the transplant, preventing any strain on the transplant.

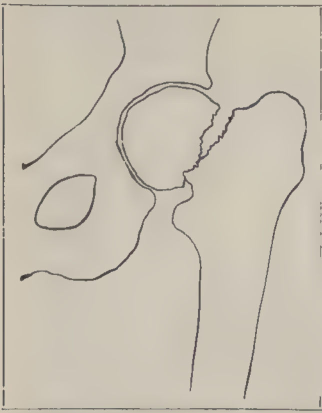

Fig. 1.—Roentgenogram tracing of an ununited fracture of the neck of the femur.

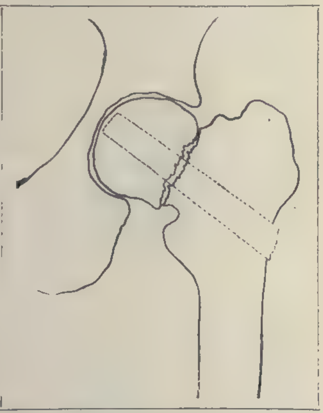

Fig. 2.—Roentgenogram tracing of an ununited fracture of the neck of the femur, showing the effect of abduction and showing the plan of bone transplantation.

Complete external rotation of the thigh will relax the muscles attached to the greater trochanter and prevent any cross-strain on the transplant.

External immobilization of the area of the transplantation is best accomplished by a plaster cast extending from the axilla to the toes, in the position of complete abduction and complete external rotation of the thigh. The opposite thigh is included to prevent shifting of the pelvis within the cast. The immobilization should be continued without change during convalescence, until roentgenograms show substantial osseous union between the fragments.

The transplant under favorable conditions grafts to the cortical bone of the lower fragment in a manner similar to the healing of wounds by primary intention.

In the live cancellous bone of the lower fragment, the process is different. It stimulates the healing of wounds by granulation. Under the stimulation of the transplantation, new bone cells are developed from the cambrium layer of the transplant and from the cancellous bone of the host, both of them rich in osteoblasts, until the transplant is embedded in a solid mass of new bone.

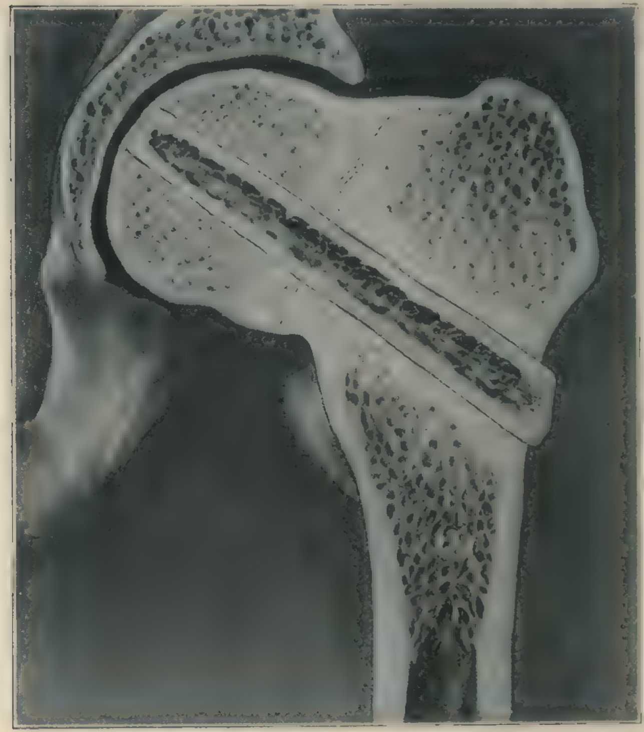

Fig. 3.—Diagrammatic vertical section of transplantation of fibula for ununited fracture of the neck of the femur, based on roentgenogram studies, one postmortem examination, and animal experimentations, showing the areas of new bone infiltration and location of callus.

In the partly devitalized cancellous tissue of the capital fragment, the process is much slower. The transplant furnishes the osteoblasts, while the surrounding cancellous bone acts as a scaffold into which the osteoblasts penetrate and develop, forming new bone which replaces the old cancellous bone as it is absorbed.

The medullary canal of the transplant is closed at each end by a thin plug of new bone, apparently produced from the endosteum. The development of new bone from all sources fills in the defect between the fragments of the ununited fracture, and produces a substantial external callus especially thick and strong at the upper part between the neck and the greater trochanter (Fig. 3).

At the time of maximum development of new bone, the upper end of the femur between the cortical bone and the transplant is filled by a dense inelastic mass of new bone without cancellous demarcation. As time goes on, measured in years, both the transplant and the new bone are absorbed and modified toward cancellous bone until there is physiologic compensation between elasticity, strength and function. After removal of the plaster, even with solid repair of the ununited fracture, substantiated by stereoscopic roentgenograms, full body-weight bearing should not be allowed until the functional movements of the hip and knee joints have been well restored by systematic massage and passive exercises.

The length of the neck of the femur has been largely destroyed before the patient comes to operation for nonunion, and it is not reproduced by transplantation; consequently, after repair of the ununited fracture the extremity is correspondingly short. The movements of the hip-joint which depend on the length of the neck of the femur for normal completion, as abduction of the thigh, are correspondingly limited.

CONCLUSIONS

1. Transplantation of a segment of fibula is an effective method of treatment for ununited fracture of the neck of the femur when the patient is physically able to assume the burden of the operative procedure and the subsequent confinement.

2. It is especially applicable in young and middle-aged subjects who belong to the wage-earning class.

3. It is contraindicated in old people, because of the shock of the operation and the prolonged immobilization.

INTERMITTENT OBSTRUCTION DUE TO GASTROPTOSIS

By CHARLES DAVISON, A.M., M.D., F.A.C.S., Chicago
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INTERMITTENT OBSTRUCTION DUE TO GASTROPTOSIS[1]

By CHARLES DAVISON, A.M., M.D., F.A.C.S., Chicago
Professor of Surgery, University of Illinois

When gastroptosis occurs to such an extent as to angulate the first portion of the duodenum, temporary obstruction may occur. The second portion of the duodenum is the most fixed part of the intestinal canal and furnishes a point over which angulation of the first portion of the duodenum may occur when certain conditions of prolapse, weight, and position of the stomach are sufficient.

The clinical history includes the usual symptoms of viceroptosis, but usually greater debility and emaciation are present. Attacks of temporary obstruction, apparently of the upper intestine, occur at varying intervals of from a few hours to several days. At times the recumbent position seems to be a factor in starting the paroxysm. During the attack there is pain in the epigastrium which is paroxysmal. There is emesis of the stomach contents and regurgitation of bile. The vomitus sometimes contains blood. After free emesis, the attack usually subsides. Constipation is generally present.

The Ewald test meal usually shows high acidity, a large amount of free hydrochloric acid, sometimes blood and bile, no lactic acid, no Boas-Oppler bacilli, no sarcinæ. There is usually slight leucocytosis.

The logical treatment of any obstruction is to remove the cause if possible; failing to do this, a visceral anastomosis is made to pass the obstruction. Supporting the stomach so that the duodenum cannot kink on itself, by palliative mechanical means, or by some method of reefing up the supports of the stomach would seem to be ideal, but is not sufficient. Posterior gastro-enterostomy seems to be necessary when the gastroptosis produces intermittent obstruction.

Case 1. M.G., American, housewife, age 42, entered University Hospital March 12, 1917, for operation for removal of gall-stones. Until one year previously the general health of the patient was good. At that time she began to have pain and discomfort in epigastric and right hypochondriac regions, especially after eating. Occasional attacks of paroxysmal, abdominal pain followed by vomit-

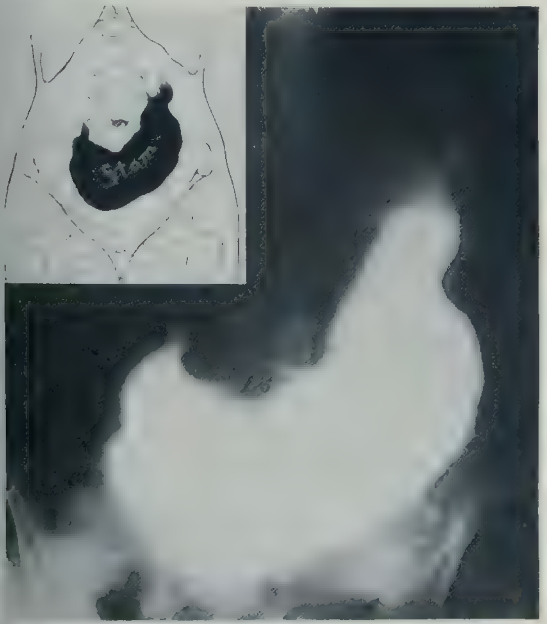

Fig. 1. Case 1. Rœntgenogram taken 10 minutes after barium meal, showing the distended stomach in the pelvis.

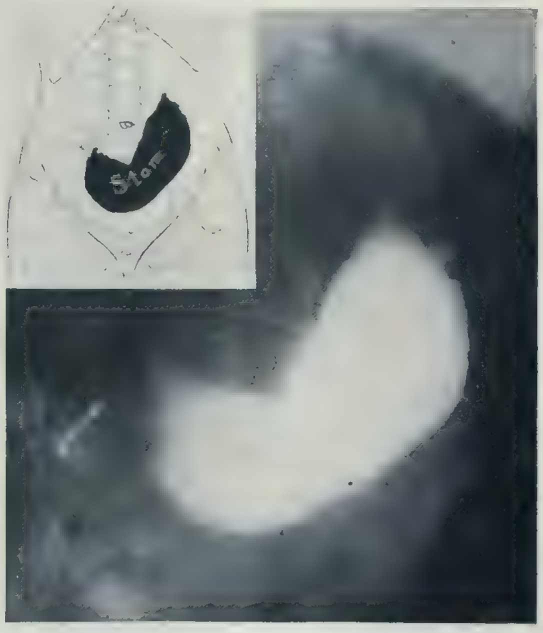

Fig. 2. Case 1. Rœntgenogram taken 16 hours after barium meal, showing the same position and distention of stomach, without passage of barium into small intestine.

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[1] Read before the Chicago Surgical Society, April, 1920.

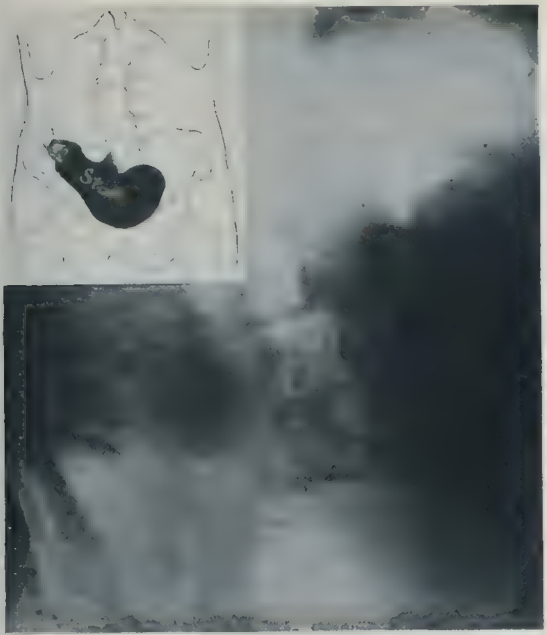

Fig. 3. Case 2. Rœntgenogram taken 10 minutes after barium meal, showing the entire distended stomach below the pelvic brim, without passage of barium into the small intestine.

ing occurred with increasing frequency and severity. These attacks would always begin while the patient was in the recumbent position and would last for several hours. The vomitus contained bile and the food contents of the stomach. Constipation was usual. Emaciation and prostration were marked. Her weight was 85 pounds, having lost 40 pounds during the year.

Ewald's test meal showed total acidity 90, free hydrochloric acid 55, no lactic acid, no bacteria, no blood, abundance of bile, leucocytosis 9,000.

A rœntgenogram, taken 10 minutes after a barium meal, shows an enlarged stomach prolapsed into the pelvis; good peristalsis of the stomach, but with little or no filling of the duodenum (Fig. 1).

A rœntgenogram taken 16 hours later shows the stomach still distended with barium; some peristalsis of the stomach still present, but the duodenum still empty (Fig. 2).

An unusually severe attack of paroxysmal pain and retching occurred during the night following the barium meal.

Posterior gastro-enterostomy was performed on the following day. The intra-abdominal examination showed the stomach to be large, muscular, and still containing barium. There was definite angulation of the duodenum, but no organic obstruction at the outlet of the stomach. The gall-bladder was empty.

Convalesence was rapid. She was relieved from the paroxysmal pain and vomiting.

At this time (3 years later) she is in good health, free from symptoms and following her usual occupation. She now weighs 195 pounds, having gained 110 pounds in 3 years.

A rœntgenogram, 3 years after operation, taken 10 minutes after ingestion of the barium meal, shows the stomach well out of the pelvis and emptying rapidly through the gastro-enterostomy, but not through the duodenum.

Case 2. J.W., American, sales manager, age 44 entered University Hospital, April 9, 1915, with the previous diagnosis of carcinoma of the stomach. His health had been poor for the past 6 years. His present illness began about 18 months previously with constant discomfort in the epigastrium, especially following meals,frequent attacks of paroxysmal pain, and vomiting. The vomitus contained food previously ingested, bile, and occasionally considerable blood. The paroxysms of pain would be temporarily relieved by vomiting. Constipation was usually present. Disability and prostration were extreme. His weight was reduced to 92 pounds.

Ewald's test meal showed total acidity 92, hydrochloric acid 64, no lactic acid, no Boas-Oppler bacilli, no sarcinæ, no blood. Leucocytosis 10,5000. Tuberculin test negative.

A rœntgenogram taken after a barium meal shows a large stomach prolapsed into the pelvis, without any filling of the duodenum (Fig. 3).

Posterior gastro-enterostomy was performed to relieve the obstruction. The intra-abdominal examination showed a large muscular stomach free from malignant or cicatricial obstruction to the pylorus or duodenum. The duodenum was sharply bent upon itself by the dragging downward of the stomach. With convalescence the symptoms were relieved and his health regained.

At this time (5 years later) he is in good health, free from symptoms and able to follow his occupation continuously. He now weighs 156 pounds, a gain of 64 pounds.

A rœntgenogram, 5 years after operation, taken 10 minutes after ingestion of the barium meal, shows the stomach emptying rapidly through the gastro-enterostomy and the duodenum.

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FATAL POST-OPERATIVE PULMONARY THROMBOSIS *

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IT has seemed worth while to consider our experience with post-operative pulmonary thrombosis in connection with a review of the most important papers which have been written upon this subject with a view to bring out any points of value in the direction of prophylaxis, as none of the methods of treatment of the condition, once it has been established, seem to have proved successful.

It seems clear from all of the many careful observations that are recorded in the literature, as well as from our own experience, that the condition does not depend upon any one cause, although most observers seem to agree upon several causes which are more important than others. In order that these views may be brought out clearly, we have stated each together with the name of its author in as concise a form as possible before stating our own observations and conclusions.

Causation.—The causes of pulmonary thrombosis in their order of importance are: (1) Local infection; (2) anæmia; (3) slowing of blood stream; (4) subnormal general physical condition; (5) cachexia; (6) micro-organisms in the blood; (7) excess of white blood-cells; (88 inefficient hæmostasis; (9) traumatization of tissues with retractors, etc.; (10) injury to veins of extremities due to badly arranged operating table; (11) injury to intima of veins; (12) excess of calcium salts in the blood.

History.—The condition has been recognized and discussed for generations. Van Swieten [8] in 1705 recognized that clots occur in the vessels during the puerperium and wrote gravely on their prognosis.

In 1784 Dr. Charles White, a distinguished London physician, did not associate pulmonary embolism with phlegmasia alba dolens.

Virchow in Berlin and Meigs in Philadelphia wrote on the subject of blood clots stopping the stream of the circulation; Virchow advocating that the obstructing clot must always travel to the heart and the pulmonary arteries; Meigs advocating that it may be formed *in situ* in the heart or pulmonary artery as well. Virchow upheld the embolus theory, Meigs the thrombosis theory.

Virchow [28] first showed the relation between thrombi and emboli, pointing out that emboli not infrequently have their origin in the softening, breaking down, and detachment of venous thrombi. He stated that in embolism the plug consists, not of blood clots, but of so-called vegetation or concretion of fibrin which has been washed off from the valves of the heart or from the endocardium and carried forward by the arterial current until the vessels become too small in calibre to allow it to advance any further.

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Anatomy.—Cohnheim and Litten[9] experimentally demonstrated the fact that the arterial ramifications of the pulmonary artery do not anastomose. They are end-arteries.

The bronchial arteries supply the parenchyma of the lung with not insignificant quantities of blood. Virchow called them the nutrient arteries of the lung. They showed that pulmonary infarcts do not result in the death of the lung, when death of the animal itself does not result, but prevent the functioning of the infarcted area for purposes of oxidation. They conclude that despite the absence of parenchymatous changes in infarcted lungs, where the quantity of infarcted lung is sufficient, death must result from disturbance of respiratory function. The bigger the obstructed artery or the larger the number of smaller obstructed arteries, the greater is the effect upon respiration, and so it happens that where multiple emboli occur successively, even without parenchymatous changes in the lungs, death must eventually ensue from respiratory insufficiency.

Anningson[1] claimed that in the pulmonary artery the clots are most commonly found at the point where it breaks up into its branches.

Mann[10] states that deaths due to pulmonary embolism should be divided into three groups: (1) Immediate death occurring when only a small portion of the pulmonary circulation is obstructed. (2) Death caused within a few minutes and due to complete or almost complete blocking of the pulmonary circulation. (3) Delayed death, the result of an increase, by thrombosis, of an initial blockage by an embolism of a portion of the pulmonary circulation.

Experimentally, it was impossible to produce death or seriously imperil the life of the animal by emboli until the pulmonary circulation was greatly obstructed.

There is a wide difference of opinion regarding the frequency with which pulmonary thrombosis occurs primarily or is due to an embolus.

Virchow[20] divided obstruction of the pulmonary artery into four groups:

1. Following compression of a branch of pulmonary artery, coagulation of the blood may occur.
2. The introduction of a deleterious substance sets up an inflammation and this causes coagulation of the blood.
3. Spontaneous coagulation of blood from causes within the blood itself.
4. Obstruction occurs through a more or less compact mass which is carried into the pulmonary vessels and becomes lodged in them.

The majority of plugs in the trunk or main divisions of the pulmonary artery found in cases of sudden death, present the anatomical characters of emboli, associated perhaps with secondary thrombi, but there remain a certain number of cases of sudden or gradual death from primary thrombosis of the pulmonary artery or from thrombosis extending into a main division from an embolus in a smaller branch.

Welch[22] showed that bland embolism in medium-sized and small branches of the pulmonary artery in normal lungs and without serious impairment of the pulmonary circulation usually causes no symptoms and no changes in the parenchyma of the lungs.

Virchow [29] pointed out that emboli fill the pulmonary arteries without adhering to the walls when they are young, while the vessel walls show no changes, but when the emboli are old they cling to the wall which shows inflammatory changes.

Emboli usually stop at the bifurcation of a large artery, usually the vessels of the second and third order (Paget). Before and behind these fresh blood coagulation may occur.

Welch[33] shows that an embolus is the starting-point of a secondary thrombosis, which usually, although not always, completes the closure of the vessel, if this was not affected by the embolus itself, and extends on each side to the nearest branch.

Humphrey [1] said thrombosis occurred most commonly at the junction of the profunda and saphena veins with the femoral. The presence of valves at the meeting-point of two veins helps to bring about the condition.

Anningson [1] thinks that inflammation might follow the clotting, but was not the cause of it.

Clots may be absorbed, leaving the veins as normal as before.

Glynn [14] believes that emboli in the pulmonary artery may be distinguished from primary thrombi by the fact that the former are coiled or fractured or riding astride of a bifurcating vessel.

Fowler and Godley hold that embolism is commoner than thrombosis (pulmonary), but spontaneous thrombus does occur. West considers spontaneous thrombosis exceedingly rare.

Welch [33] believes in the usually accepted opinion that the majority of plugs found in the pulmonary artery and its main divisions in cases of sudden death are emboli.

Recently, Mery [14] in France and Newton Pitt in this country have maintained that spontaneous thrombosis is not infrequent, that in fact it may be commoner than embolism.

Box,[5] after making careful autopsies of several cases of so-called pulmonary embolism, came to the conclusion that these cases are a combination of thrombosis with embolism. He considers that a clot first forms in the pulmonary artery or in the right side of the heart and some sudden movement causes detachment of this clot which enters and completely plugs one or both pulmonary arteries.

He explains that a clot forming in the pulmonary artery or right ventricle very soon after the operation may become absorbed without producing symptoms, but it may increase in size, become detached and then plug the pulmonary artery.

Wilson [33] thinks it is probable that obstruction of the pulmonary artery sometimes occurs without proving fatal.

According to Foulkrod,[13] embolism of the pulmonary artery is invariably fatal. When involving the small blood-vessels in the lungs it may produce atalectasis, infarct, abscess or gangrene and the patient may recover.

Welch[32] states that asphyxia, cerebral anæmia, or interference with the coronary circulation are the factors concerned, but the exact apportionment to each of its due share in the result is not easy, nor very important.

Dr. Wm. Zahn [35] made a very extensive study of the formation of thrombi. His work will always stand out as a classic upon this subject and should be studied in detail in considering this subject.

Incidence.—In McLean's [20] experience emboli and embolic abscesses follow 2.2 per cent. of all laparotomies.

Ritzman [34] reported fifty-five cases in 6000 autopsies. All patients were over thirty years of age, and most were between fifty and seventy. There were as many females as males.

Bang[3] reported eighty-eight cases of embolism, one-half of which occurred in persons between twenty and thirty years of age.

In Lichtenberg's[22] collection of 23,680 operations, including 16,000 laparotomies, there were 2 per cent. of pulmonary complications and among the laparotomies 5.5 per cent.

Among 1000 operations on the vermiform appendix, Muhsom[22] reported thirty-one cases, five of which were fatal.

Mauclair[22] has collected fifty cases after the radical cure of inguinal hernia, twelve out of twenty-five fully reported being fatal.

The prognosis of post-operative pulmonary embolism is extremely grave; in 233 cases collected by Lenormant, death occurred in 106 or 45.5 per cent.

The order of frequency in which emboli are found in the different arteries may be given as follows: pulmonary, renal, splenic, cerebral, iliac and lower extremities, axillary and upper extremities, cœliac axis with its hepatic and gastric branches, central artery of the retina, superior mesenterics, inferior mesenterics, abdominal aorta, coronary, and the heart.

Lotheisen[18] collected sixty-six cases of pulmonary embolism, of which fifty-five were fatal:

1. Following fractures, thirty-six cases; thirty fatal.
2. Contusion, six cases; five fatal.
3. Tendon and muscle lacerations, four cases; four fatal.
4. Following operations, twenty cases; sixteen fatal.

Of Lotheisen's sixty-six cases, only six were under thirty, the majority being over forty. Of his sixty-six cases, forty-one were males, twenty-two females, and three unspecified.

Bang[3] found ten cases of embolus in 600 autopsies—1.66 per cent.

According to Wilson,[28] in operations on blood-vessels, alimentary canal, and genito-urinary organs, from 1 to 2 per cent. of all cases give more or less distinct evidence of emboli, about 7 per cent. of which are in the lungs.

About 10 per cent. of post-operative emboli which give clinical symptoms cause death.

Foulkrod[13] found thirty-seven cases of proved or suspected pulmonary embolism. According to his observations, thrombosis and embolism (not confined to pulmonary) occur in from 1 to 3 per cent. of cases, including both post-operative and obstetric. Obstruction of the pulmonary circulation alone occurs in a very much smaller percentage of cases.

Beckman, quoted by Van Sweringen,[28] reports six cases of pulmonary embolism occurring at Rochester in the first eight months of 1910 out of 4530 consecutive cases operated upon.

Kelly and Cullen report four deaths from pulmonary embolism out of 901 hysterectomies.

Howard showed that venous thrombosis occurred thirty-four times in 3774 patients with appendicitis and that a little less than one-eighth of these were cases of pulmonary embolism.

Albanus found that pulmonary embolism followed in 2 per cent. of abdominal operations.

Burkhard gives in 236 operations for uterine fibroids twelve cases of embolism (Keen's Surgery).

In Bidwell's[5] practice pulmonary embolism or thrombosis has occurred in .5 per cent. of abdominal operations.

The risk of pulmonary thrombosis after an appendectomy in the quiet stage is not merely a nominal one, since three such cases occurred in Bidwell's practice and represent a mortality of nearly 1 per cent. after operation, the death rate from other causes being only .4 per cent.

Out of 700 obstetrical cases, Church[8] saw only one case of pulmonary embolism. These cases are evenly divided between primiparæ and multiparæ.

Playfair[23] states that as far as present statistics go, thrombosis and embolism seem more common in primiparæ than multiparæ.

Lotheisen[18] states that emboli occur, as a rule, in adults. Only one case of a child with pulmonary embolism could be found in the literature—a year-and-a-half-old boy with diphtheria and pneumonia.

Bidwell[6] thinks that pulmonary embolism after abdominal operations may be more frequent than is generally supposed and that its apparent rarity may be due to the surgeon's natural dislike to attract attention to his fatal cases.

McLean's[20] studies and observations have convinced him that a far greater percentage of post-operative ailments than we are accustomed to attribute to embolism really owe their origin to that cause.

Etiology of Thrombosis.—Welch[32] states that slowing and other irregularities of circulation in combination with lesions of cardiac or vascular wall or with the presence of microörganisms or other changes in the blood are important predisposing causes of thrombosis and frequently determine the localization of the thrombus.

2. Changes which impair or destroy the smooth surface of the normal inner lining of the vessel play an important part in the etiology of thrombosis (inflammation, atheroma, calcification, necrosis, other degenerations, tumors, compression and injury).

3. Infective thrombi (thrombophlebitis) develops during the progress of pneumonia, typhus, acute rheumatism, erysipelas, cholera, scarlatina, variola, tuberculosis, syphilis, nearly all acute and chronic infections. Likewise in chlorosis, gout, leukæmia, senile debility and chronic wasting, and cachectic diseases, particularly cancer, thrombosis is a recognized complication.

4. Chemical changes in the blood-ferment thrombi. Alterations in the formed elements of the blood caused directly or indirectly by toxic substances are of great significance in the etiology of pulmonary thrombosis.

a. Increase of blood platelets—there is a parallelism between the disposition to thrombosis and the number of platelets in certain diseases.

b. Calcium content is an important factor in coagulation of blood.

As factors in the causation of thrombosis, Lotheisen[18] considers:

1. A change in the blood constituents.
(*a*) Anæmia (puerperal hemorrhage or uterine hemorrhage due to myoma uteri).
(*b*) Gestation (physiological changes in blood and leucocytosis).
(*c*) Chlorosis.
(*d*) Prolonged fevers, malaria, cholera.
(*e*) Elephantiasis (Fayrer, three cases).
(*f*) Cachexia-malignant tumors.
2. Slowing of blood stream.
(*a*) Weak heart.
(*b*) Fatty degeneration—pregnancy.
(*c*) Pregnancy—gravid uterus pressing on veins.
3. Change in the vessel wall.
(*a*) Phlebitis.
(*b*) Trauma.
(*c*) Atheroma.

Wilson[33] states that the most important factors concerned in extensive post-operative thrombosis are:

(*a*) Injury of vascular walls.
(*b*) Slowing and stagnation of blood-stream.
(*c*) Disintegration of the corpuscles of the blood from toxic substances.
(*d*) Bacteræmia.

Foulkrod[13] enumerates as pathological conditions influencing coagulation the following: Preëxisting thrombosis, toxæmia or infections—under this heading he includes infections of the endometrium and broad ligament veins and particularly bronchial infections, profound mental depression, placenta prævia or other conditions producing excessive hemorrhage, mechanical pressure from the weight of the uterus, and slowing of the heart action.

Playfair[23] believes further thromboses of heart and pulmonary artery are sometimes due to dysentery; typhus and typhoid fever may also cause death by thrombosis of pulmonary artery.

According to Ritzman's[24] observations, the causes were various: vitium cordis, myodegeneration, arteriosclerosis, anæmia and cachexia, conditions causing phlebitis, injuries and operations. Nearly all the affections were related to vascular disease of some sort.

Church[8] claims that thrombosis is induced in puerperal state, rheumatism, fevers and other blood dyscrasiæ, such as erysipelas, diphtheria, pneumonia—increase of fibrin in the blood one third.

Bidwell[6] says pulmonary embolism is unpreventable since the active cause as well as the means of prevention are not known.

It is the opinion of Bidwell that thrombosis occurs only in consequence of changes in the blood-vessels, the blood, or both. A thrombus, of course, is formed by the development of fibrin; but fibrin does not exist in healthy blood, but is produced by the action of fibrin ferment on fibrinogen. Fibrin ferment does not exist in the blood, but is the result of a combination of calcium salts with nucleo-proteid. Calcium salts are normal constituents of the blood, but nucleo-proteid is not, and it is probably produced by degeneration of leucocytes and of blood platelets. In normal circumstances a considerable quantity of nucleo-proteid can be disposed of in the circulation, probably by the action of the endothelial lining of the blood-vessels; this power is, however, diminished by injury, by inflammation, and by retarding of the blood-stream.

Therefore, thrombosis forms when the walls of the blood-vessels have been injured; also in cases of sepsis, by increase of CO_2 in the blood, by general conditions, such as chlorosis and anæmia, and lastly by specific fevers, more especially typhoid.

Bland Sutton,[6] in his Hunterian lecture, is convinced that the formation of thrombi in the great veins after pelvic operations is due in all cases to sepsis.

Faure[11] describes two fatal cases occurring within a few days operated between February 12 to 24, 1919, during the influenza epidemic after the clinic had been free from such fatalities for many months, thus attributing these cases to influenza infection. At the same time, there were three additional cases of phlebitis and numerous cases of wound infection during this period, while the clinic had been free from all of these complications for months.

McLean[20] has shown how, except in the presence of an infection, it was impossible to produce experimentally a thrombus and a resulting embolus, and for this reason claims that a perfectly aseptic operation is rarely followed by an embolic process.

He insists that endothelial damage, on which so much stress is generally laid, is not, *per se*, a cause of thrombosis. Infection and necrosis (or the toxins derived from an infection and necrotic process) are probably the most important factors in thrombus production. A slowing of the blood-stream is a contributory cause, but of itself will not cause a thrombus to form.

Fromme[12] introduced a silk thread into the jugular vein of rabbits. A sterile thread produced a thrombosis only in anæmic animals or in those in bad physical condition, while the thread impregnated with any form of bacteria regularly produced thrombi.

Talke[28] said he had placed culture of staphylococci near thirteen arteries and thirty-one veins in thirteen animals, and he removed these after nine to twelve hours. Twenty-two veins and eleven arteries were thrombosed. The vessel wall and the surrounding tissues showed typical inflammation, but the thrombosis occurred before the microörganisms had entered the lumen of the vessel, hence seemed to be caused by the toxins.

Bidwell[5] quotes some surgeons who assert that all cases of thrombosis are really septic in origin, but states that it is difficult to agree with this statement, since it occurs in aseptic cases and in such a case as a gastric ulcer.

Libanoff[17] explained the formation of thrombokinase in large hæmatomata leading to the danger of local or distant thrombosis and pointed out the necessity of evacuating these to avoid their absorption. Commenting on this, Murphy asks: "Why has one clinic so many cases of thrombosis and embolism and the other clinic so few?" May it not be due to imperfect hæmostasis by one operator and the perfect capillary hæmostasis of the other? In the first instance, large hæmatomata form, and the latter give up the thrombokinase and thrombosis follows; while in the other no hæmatomata form and consequently no thrombokinase is given out, and therefore no activity of thrombogen occurs with the calcium salts to form a thrombus.

Volker[30] said he was surprised to find in necropsies on animals dead of embolism that there was invariably some brownish liquid blood in small quantities at the bottom of the wound, and it occurred to him that there might be some relation between the debris of these small hæmatomata and fatal embolism. He believed the debris from the hæmatomata should be looked upon as the cause of embolism.

Dr. Joseph Price, quoted by Volker,[30] called attention to the dangers of these small "blood pools" in the pelvis following operations as early as 1893 and placed great stress upon the danger from them and the importance of leaving the field of operation perfectly dry.

After delivery the blood dyscrasia is increased by the absorption of effete matter in the process of uterine involution. Severe hemorrhage and syncope with slowing of the blood-stream increase the tendency to coagulation. Plugs normally found in natural labor in the open orifices of the uterine sinuses after separation of the placenta may find their way into the systemic circulation.

Zurheile[36] claims that retardation of blood-stream is the main factor in the production of a thrombosis, so that the blood plates pile up mechanically in the more sluggish blood. His experiments show the uselessness of striving to prevent thrombosis by reducing the coagulating property of the blood; as we are unable to act on the blood plates, all we can do is to prevent the blood-stream from becoming sluggish.

Aschoff[2] suggests that it may be possible to prevent thrombosis by changing the physical condition in the circulation, combating any tendency to slower pulse rate. He does not think that thrombosis is always of infectious origin, but a superimposed infection transforms a primary insignificant thrombosis into a dangerous thrombophlebitis. He supports the theory advanced by Virchow that the slowing up of the stream is the principal factor in the development of thrombi.

All cases observed by Glynn[14] of pulmonary thrombosis had been bed-ridden, and passive congestion of the lungs may have been a predisposing cause of thrombosis. It is also a fact that nine cases had been anæsthetized.

Bardeleben[4] showed that streptococci introduced into the blood-stream produce a thrombosis only if the stream is slowed down, otherwise non-virulent varieties are destroyed, while virulent varieties produce severe bacteræmia if highly virulent streptococci become lodged upon the vessel wall.

Bidwell[5] points out the fact that when thrombosis attacks a femoral vein, the left is most usually affected, and this is explained by the course of the left iliac vein being less direct than that of the right and also by the fact that the flow of blood through it is likely to be retarded by the pressure of a loaded sigmoid.

Playfair[23] believes that central thrombosis (cardiac and pulmonary) should be looked upon as a complication which is liable to attend the performance of surgical operations in general, but more especially those done on cachectic subjects or those involving much shock or hemorrhage.

He also states that both thrombosis and embolism are much more common in patients who are anæmic and weak either from hemorrhage or other cause.

Duncan[5] argues that it is due to anæmia, which so frequently affects women suffering from uterine fibroids, and supports his views by quoting a case of a woman with fibroids dying from pulmonary embolism while in the hospital awaiting operation.

Clark, quoted by Van Sweringen,[28] believes that thrombosis in non-septic epigastric veins is due to propagating thrombus of the deep epigastric veins originally produced by the traumatism resulting from operative manipulations and especially the use of heavy retractors.

Others maintain that post-operative thrombosis is caused by the pressure of retractors on the edges of the abdominal wound causing injury to the deep epigastric veins; the thrombus forms first at the seat of injury and afterwards spreads down to or around to the femoral vein.

It is generally supposed that patients suffering from uterine fibroids are peculiarly liable to thrombosis and embolism; this is explained (1) by the increase of calcium salts in the blood, as shown by the tendency to calcareous degeneration of the fibromata, and (2) by some degeneration and weakening of the cardiac muscle fibre which is commonly associated with the condition and, according to several authors, to the fact that the stump left after the removal of the uterus has not been carefully covered with peritoneum after accomplishing perfect hæmostasis, thus favoring infection.

Anningson[1] thought it possible that the tendency to coagulation during the puerperal state and in pneumonia, erysipelas, etc., was due to excess of white corpuscles in these conditions.

Virchow[29] believed that the fibrin clots or pulmonary emboli were secondary to thrombosis elsewhere. This thrombosis occurs in the veins or right heart, and is carried to the pulmonary arteries by the blood-stream.

To substantiate this he reports that out of seventy-six sections performed in August in the Morgue of the Berlin Charities he encountered eighteen venous thromboses and six lung or pulmonary thromboses.

Obstruction may or may not cause change in the parenchyma.

When the blood in one vein clots, the coagulum extends beyond the mouth of the next vein, so that, as the blood from this vein passes by, small pieces of coagulum can easily be detached. Virchow has been able to match the edges of pulmonary emboli with those of venous thrombosis from which they originated.

Wilson[33] states 80 per cent. of emboli have their source in venous thrombosis, 10 per cent. are cardiac and 10 per cent. scattered and undeterminable. Long, loosely formed thrombi from medium-sized veins are those chiefly concerned in embolism. When large, loose thrombi are formed in resting patients, any unusual exertion or change of position may cause a dislocation of large masses which become dangerous emboli.

Church,[3] quoting Playfair in his "Science and Practice of Midwifery," says, "I have shown from a careful analysis of twenty-five cases of sudden death after delivery, in which accurate post-mortem examination has been made, that the cases of spontaneous thrombosis and embolism depend upon the period after delivery at which the fatal result occurs. In seven of these cases there was distinct evidence of embolism, and in them death occurred at a remote period after delivery, in none before the nineteenth day. This contrasts remarkably with the cases in which post-mortem examinations afforded no evidence of embolism. These amounted to fifteen out of twenty-five; in all of them, with one exception, death occurred before the fourteenth day, often on the second or third. The reason for this seems to be that in the former, time is required to admit of degenerative changes taking place in the deposited fibrin, leading to separation of an embolus; while in the latter, the thrombosis corresponds in time and to a great extent no doubt also in cause to the original thrombosis from which in the former the embolus was derived. Many cases I have since collected illustrate the same rule in a very curious and instructive way."

Playfair[23] expresses the following opinion:

Obstruction of the pulmonary artery after delivery may depend upon either embolism or spontaneous thrombosis.

The former usually occurs at a much later period after delivery than the latter, and spontaneous thrombosis probably corresponds with and is due to some cause similar in its nature to that which produces the obstruction of the peripheral veins in true cases of embolism.

Church[8] states thrombosis may occur simultaneously at the periphery (veins) and centre (heart and lungs) of blood-stream. Dr. W. J. Playfair cites cases of pulmonary obstruction that have not proved fatal immediately and in which shortly afterwards phlegmosia dolens commenced, showing thereby that coagulum was first formed in the centre and then at the periphery.

Thrombosis rarely occurs till one week after an operation; from the tenth to the fourteenth day is the usual time, but sometimes it is as late as one month. Recovery is generally complete in from two to three weeks. As a rule, these cases do not suffer from pulmonary complications, and in those rare cases in which sudden death does occur after a femoral thrombosis, it is probable that a thrombosis coexisted in the pulmonary artery.

Etiology of Embolism.—Lotheisen[18] makes the following observations: Most emboli originate from the veins of the lower extremity. In his sixty-six cases, forty originated there.

Following parturition or gynæcologic operations, emboli have originated from thrombosis of veins about the uterus.

The hemorrhoidal plexus has also been indicted several times.

Bumm describes two cases following operation on the rectovaginal septum.

Embolism usually occurs after a previous period of rest in bed followed by sitting up, straining at stool, or muscular effort, manipulation or massage of the leg, rubbing in ointment or even the application of a bandage or zinc gelatine boot (Velpeau).

Wyder[36] saw pulmonary embolism following colpoperineal plastic.

Symptomatology of Thrombosis.—Pain, swelling, masses in superficial veins (or deep veins).

Thrombosis—sudden pulse rise with normal temperature, later temperature rise with embolism. After this temperature may descend while the pulse remains elevated (Mahler[34]).

Welch[32] gives one of the clearest descriptions of symptoms. Death may be instantaneous from syncope. More frequently the patient cries out, is seized with extreme precordial distress and violent suffocation, and dies in a few seconds or minutes. Or when there is still some passage for the blood, the symptoms may be prolonged for several hours or even days before the fatal termination. The symptoms of large pulmonary embolism are the sudden appearance of a painful sense of oppression in the chest, rapid respiration, intense dyspnœa, pallor followed by cyanosis, turgidity of the cervical veins, exophthalmos, dilatation of the pupils, tumultuous or weak and irregular heart action, small empty radial pulse, great restlessness, cold sweat, chills, syncope, opisthotonous and convulsions. The intelligence may be preserved or there may be delirium, coma, and other cerebral symptoms. Particularly striking is the contrast between the violence of the dyspnœa and the freedom with which the air enters the lungs, and the absence of pulmonary physical signs, unless in the more prolonged cases, it be the sign of œdema of the lungs.

Wyder[34] enumerates the symptoms of pulmonary embolism as follows: (1) dyspnœa (cardiac apnœa); (2) anxiety; (3) cyanosis; (4) dilated pupils; (5) powerful and irregular heaving of heart; (6) pulse imperceptible; (7) death following syncope.

Auscultation during pulmonary embolism reveals often a blowing murmur during systole or systole and diastole at the base. Henning heard this in 4 cases out of 33.

In Lotheisen's 66 cases it was reported 3 times. Pain in the region of the scapula or in the right or left hypochondrium. Consciousness is usually retained to the last. Rarely delirium, syncope, or convulsions occur. Sense of coldness complained of; they frequently shiver.

Regarding the diagnosis, Meyer[20a] considers next to the clearly demonstrable enlargement of the right heart, the accentuation of the second pulmonary sound of importance.

Differential Diagnosis.—Wyder[34] states that atheroma of coronary arteries gives a similar picture. These patients usually give a history of previous similar attacks.

Schumacher[30] calls attention to the fact that the diagnosis of pulmonary embolism may be difficult because a suddenly occurring internal hemorrhage, also myodegeneration of the heart, can produce like symptoms.

Prophylactic Treatment.—Many suggestions have been made in the direction of prophylactic treatment, of which the following are the most important.

Wyder[34] lays down the following rules:

(*a*) In chlorosis give iron.

(*b*) In cases of pregnancy avoid operation in the neighborhood of the uterus, anus, and vulva if possible. Such operations may cause miscarriage, which aids in liberation of emboli.

(*c*) In cases of operation avoid hæmatomata, because thrombosis is readily set up in adjoining veins.

(*d*) In cases of venous stasis in the lower extremities elastic bandages and massage are recommended to avoid thrombosis. If thrombosis is suspected, however, these should not be employed (v. Jurgensen). The author condemns massage in all cases for fear of liberating emboli.

(*e*) For the same reason, Puternan goes so far as to avoid massage in all cases of fracture until three weeks after injury.

(*f*) In cases of thrombosis all movements should be avoided. Patients should not sit up in bed. Straining at stool should be avoided by the use of proper cathartics.

(*g*) Elevation of the leg has no value.

(*h*) Cold compresses changed every hour or two and laid on the anterior surface of the leg, so as not to make necessary the elevation of the leg, are advised.

Rest in bed is mandatory as long as symptoms of thrombosis or capillary thrombi are present. Even after the swelling has disappeared the patient should remain in bed for several days.

Tally recommends as a prophylactic measure that good contraction of the uterus should be sought after labor.

In endocarditis undue muscular effort, including straining at stool and severe coughing should be avoided.

Thane[27] suggests the undesirability of prolonged use of Trendelenburg position, as it may predispose to pulmonary embolism.

Ward[31] speaks of the abandonment of extensive exposure of the levator ani muscle during perineoplasty to prevent bruising of the numerous small veins exposed.

The length of time that a limb should be kept immobilized should be gauged by the disappearance of swelling, tenderness and fever which often takes one or two months. The return to normal activity should be by easy stages.

Grober[15] advises where possible the excision of the original site of thrombosis.

When thrombo-embolism occurs, keep patient absolutely at rest in bed and give morphia for distress.

Welch[32] advises the following points in the treatment of thrombosis:

(*a*) Prophylactic measures should be directed toward maintaining good nutrition, strengthening the heart's action and warding off secondary infection.

(*b*) He mentions the use of citrated milk; 20 to 40 grains of citrate to the pint in diseases conducive to thrombosis.

(*c*) Absolute rest, suitable position, and immobilization of the thrombosed extremity, and nourishing diet to ward off embolism.

Caution patient against moving the leg; palpation of affected limb should be of the gentlest sort and is better omitted altogether. The patient should not be allowed to walk in less than forty days. After the danger of embolism is passed, massage and bandaging may be employed to advantage.

Wilson[33] enumerates the following precautionary measures:

(*a*) Reduction of vascular traumatism to minimum at operation.

(*b*) The encouragement of very early free movement on the part of the patient.

(*c*) The post-operative administration of drugs to increase the coagulability of the blood is of questionable value as far as thrombosis and embolism are concerned.

(*d*) Measures leading toward the reduction of bacteræmia. Eliminate foci of infection, treat with vaccine, etc.

Bidwell[5] insists that methods of prevention are of more importance than methods of treatment, and these include the treatment of anæmia before operation, giving excess of fluids, the use of citrates, and getting the patient up as soon as possible after operation. At the same time lime salts, magnesium carbonate and milk should be avoided.

He states that the tendency to coagulation is decreased by oxygen, by improving the force of the circulation, by alcohol, by excess fluids and reduction of solids, by citric acid, rhubarb, acid fruits and wines and by tobacco.

Wyder[34] considers the most important prophylactic measures to recognize the presence of thrombosis and avoid everything which may loosen emboli.

Thorough blood study in cases of anæmia he advises to postpone operation until this is relieved. Administer iron in these cases.

To prevent femoral thrombosis after an operation Bidwell[5] believes that we should avoid the risk of injury to the edges of the wound by placing gauze pads beneath our retractors, and by using them as gently as possible; we should avoid an exclusive milk diet; we should keep the lower bowel unloaded, so as to minimize the interference with the blood-stream through the common iliac vein by pressure from the sigmoid; we should give excess of fluids, especially by rectum, and we should avoid calcium salts and carbonate of magnesia. The patient should have plenty of fresh air and should be given citrates, if milk is allowed.

Th. Kocher agreed with Volker[30] and went still further, saying that he sought for locations where there may have been old thrombi, *e.g.*, in the varices of the leg. He thinks it clearly indicated to cure such varices before subjecting the patients to major operations during which they may succumb to embolism. For this purpose he makes use of ligatures of the large saphenous by Trendelenburg's method by multiple intermediate ligations of the varices.

Playfair [23] agrees that the main element in the treatment of such cases is the most rigid rest and a nourishing supporting regimen.

Paul Zweifel [37] reports eighteen pulmonary thrombosis deaths in 1832 cases operated upon a table interfering with the veins of the lower extremities and only three in 860 cases operated upon a table which did not have this feature. In the former series, the deaths from this cause amounted to one in 100; in the latter series, one in 286.

He advises the following precaution which, according to his enormous clinical experience, will greatly reduce the occurrence of pulmonary thrombosis. Avoid all pressure upon the veins of the lower extremities, such as occur from permitting the legs to hang over the lower end of the table in operations in the Trendelenburg position with the use of the tables which drop the lower end.

He gives further statistics, according to which he lost five cases from thrombosis in 450 abdominal sections; three in operations for uterine fibroids, one for carcinoma of the uterus, and one for extirpation of a cyst in a patient seventy-five years of age. Following this high mortality, notwithstanding the fact that the extremities were not traumatized during the operation, a change in the technic was followed by only five deaths from thrombosis in 2060 laparotomies and only one in 484 operations for uterine fibroids, and this in a patient who had suffered eight weeks previously from a cerebral embolus. All the five deaths mentioned occurred in decrepit, anæmic, or cachectic patients.

The change in technic consisted in the absolute control of oozing of blood and in applying a purse-string suture covering absolutely all raw surfaces in the pelvis.

R. Olshausen [22] attributed the frequent occurrence of pulmonary thrombosis to the use of an operation table which caused the knees to be flexed in placing patients in the Trendelenburg position, causing a compression of the veins of the lower extremities; 2443 with 14 pulmonary thromboses; of these there were 571 uterine fibroids, with seven thromboses. Following these cases he reported fibroids with no thromboses in cases operated on a table without compression of the veins of the legs.

Therapeutic Treatment.—According to Wyder,[34] upon the occurrence of pulmonary embolism rapid therapeutic measures are necessary.

1. Subcutaneous injections of ether and camphor in oil. Von Kenezy gave ether injections hourly for two days and claims that the patient felt definite alleviation after each. Oeder gave .2 gram camphor every five minutes or 2.4 grams in one hour, and claims a recovery with this. Caffein and digitalis may be used intravenously.

2. Morphia .02 gram, used by most clinicians, counteracts shock, and if death supervenes, makes this less painful.

After infarction combat dyspnœa and distress with opiates.

Lead acetate may be administered. He does not hold artificial respiration useful, because death does not occur from respiratory obstruction but rather lack of oxygen in the blood.

Bidwell [5] states with regard to treatment, while he recognizes that little can be done when the whole of the right pulmonary artery is blocked; oxygen, strychnine, and saline injections are always given, and in one case life was prolonged fifteen hours.

Church [8] urges the use of oxygen gas inhalation for these patients on the basis of its demonstrated value in the treatment of pneumonia.

Meyer [30a] describes the removal of pulmonary emboli by Trendelenburg's operation in detail. Trendelenburg performed twelve operations of this kind on man without a permanent recovery.

He states that the coagulation of blood and recurrence of embolic accident can be avoided by injection of hirudin.

He distinguishes three classes of pulmonary embolism:

1. The one causing immediate exitus which evidently is due to shock, as not infrequently only a partial thrombosis of the artery may be found at autopsy.

2. The one causing death within a few minutes. Here thrombosis is perfect, separating pulmonary and greater circulation. The right heart becomes quickly overdistended.

3. The one of protracted course which is more frequently observed. Here one of the main branches of the artery and subdivisions become suddenly clogged, only gradually total obstruction sets in.

As a matter of fact, only the third category will furnish cases with indication for operation and the task of establishing this indication is rendered difficult on account of the experience that some of these patients get better under conservative treatment. He considers operation imperative if medical treatment fails to bring improvement.

Four times this operation was performed at the Zurich Clinic, but the patients could not be saved.

Table of Cases of Death Due to Pulmonary Thrombosis During the Five Years 1915 to 1919 in the Augustana Hospital

	Date	No.	Sex	Age	Diagnosis	Operation	Operator	Post-operative days	Predisposing cause of embolism
1	7/15/15	43793	M	42	Osteochondroma of left ileum	Excision of osteochondroma	A. J. O.	4	Phlebitis.
2	9/ 4/15	44273	M	46	Gastric ulcer; cholecystitis, chronic appendicitis	Posterior gastro-enterostomy cholecystectomy; appendectomy	N. M. P.	6	Perforated ulcer with preoperative loss of weight.
3	4/13/16	46790	F	33	Cholecystitis, retroversion, rectocele	Cholecystectomy perineorrhaphy	N. M. P.	2	
4	7/ 7/16	47388	F	44	Carcinoma of rectum	Colostomy	A. J. O.	3	
5	5/21/17	50718	M	65	Hypertrophied prostate	Suprapubic prostatectomy	N. M. P.	15	Cachexia; phlebitis left leg.
6	6/12/17	50802	F	33	Gestation; 3rd degree laceration perineum	Parturition perineorrhaphy	R. H.	14	Perineal sepsis.
7	4/28/18	54315	F	51	Cholelithiasis; carcinoma of rectum	Cholecystostomy panhysterectomy	A. J. O.	7	Anæmia; cachexia.
8	12/16/18	56932	F	43	Floating kidney; cholecystitis; appendicitis	Nephropexy; cholecystotomy; appendectomy	A. J. O.	12	Preoperative loss of weight, 35 pounds.

Year	Operations	Obstetrical deliveries	Laparotomies	Hysterectomies
1915	3,665	153	1204	94
1916	3,510	187	1218	88
1917	3,303	211	927	133
1918	3,303	278	871	107
1919	2,915	270	1055	106
	16,696	1099	5275	528

Seven deaths in 16,696 operations = 1 case in 2385 = 0.042 per cent.
One death in 1099 obstetrical cases = 1 case in 1099 = 0.1 per cent.
Five deaths in 5275 laparotomies = 1 case in 1055 = 0.1 per cent.
One death in 528 hysterectomies = 1 case in 528 = 0.5 per cent.

We have reviewed the histories of all cases of death due to pulmonary thrombosis which occurred during the past five years in the Augustana Hospital following surgical operations, including the years 1915 to 1919, eight cases. These are represented in the accompanying table. Of these, four cases occurred in my own service, three in the service of my colleague, Dr. N. M. Percy, and one in the obstetrical service in a patient in which a very extensive perineal laceration had to be repaired immediately following delivery. It is likely that the thrombosis had no relation to the operation, because deaths from this cause have occurred many times after delivery of cases in whom no surgical repair was made, but in order to make our statistics complete the case had to be included.

During these years 16,696 operations were performed in all in the Augustana Hospital with 5275 laparotomies, and of these 528 were hysterectomies which in all other statistics we have encountered showed the largest percentage of deaths from pulmonary thrombosis.

During the same period 76 cases of so-called pernicious anæmia were operated for splenectomy, cholecystectomy and appendectomy in patients who, according to all statistics, should have resulted in a considerable number of deaths from pulmonary thrombosis. Among these cases, most of which were operated by my colleague, Dr. N. M. Percy, there occurred no deaths from this cause.

In every case, however, the operation had been preceded by one or more transfusions of whole blood without the addition of citrate of soda.

Recognizing the etiological importance of the twelve conditions mentioned at the beginning of this paper, whose validity seems to have been established by many authorities noted for their keenness of observation, it would seem worth while to investigate whether death from pulmonary thrombosis could have been avoided in any or all of these cases had every possible precaution been taken to eliminate each one of these etiologic factors to the greatest possible extent.

1. *Local Infection.*—It seems certain that even the slightest amount of local infection may cause a thrombosis in a neighboring vein which may be loosened and serve as the cause of a fatal pulmonary thrombosis when it becomes lodged in the pulmonary vein. Although there is no evidence in any one of our cases that this has actually occurred, yet it seems important to still further perfect aseptic methods of operation. Of course, hæmostasis must be accomplished as a result of a normal thrombosis of the ends of the cut vessels, but it does not seem likely that such a thrombus will ever become loosened, so that it can cause death due to pulmonary thrombosis.

2. *Anæmia.*—Most of the patients, especially Cases II, V and VII, showed some degree of anæmia. It seems likely that it might have been possible to correct this by more careful preliminary treatment or by transfusion of whole blood.

3. *Slowing of Blood Stream.*—It has been claimed that keeping patients for a long continued operation in the Trendelenburg position would interfere with the blood stream in the extremities to such an extent that this serves as a predisposing cause. In none of our cases, except

Case II, could this have been the cause, as none of the other operations were of long duration.

4. *Subnormal General Physical Condition.*—This obtained in Cases II, VII and VIII, but aside from the possible improvement which could have been secured by the preliminary transfusion of whole blood, it is doubtful whether this cause could have been eliminated to a marked extent.

5. *Cachexia.*—The only treatment which could be of any benefit would again be the transfusion of whole blood. Two of our own cases belonged to this group, and were similar cases to come under our care in the future, we should make use of prophylactic transfusion of whole blood.

6. *Microörganisms in the Blood.*—None of our cases belong to this group, but we believe that in several cases of this class we have obtained great benefit by the transfusion of whole blood, although it is, of course, impossible to state that thrombosis has been prevented in any given case, although it failed to appear in any of these following transfusions.

7. *Excess of White Blood-cells.*—This cause did not exist in any of our cases.

8. *Inefficient Hæmostasis.*—Until very recently we had not fully appreciated the importance of this etiologic factor, and it is quite possible that some of our deaths may have been due to an error in this direction, although fortunately our method of closing the stump in hysterectomy for many years has corresponded to that upon which Zweifel[37] lays so much stress, and it is possible that we may have escaped many deaths from pulmonary thrombosis in this class of cases without being entitled to any credit for this.

9. *Traumatization of Tissues with Retractors, Etc.*—It seems likely that we have not exercised proper care in this direction, because until recently we have made use of heavy retractors for holding open the abdominal wound. These have now been discarded, and although we cannot trace any case directly to this cause, it seems likely that our technic has been bad in this direction.

10. *Injury to Veins of Extremities Due to Badly Arranged Operating Table.*—Zweifel and others have traced a number of their cases directly to the use of a table in which the knees are bent, so that the veins are compressed during the operation. They found a marked reduction of fatal cases upon abandoning this particular table. We have never used this type of table, but it seems proper to again direct attention to this apparent cause.

11. *Injury to Intima of Veins.*—Rough handling of tissue in the vicinity of the wound undoubtedly often causes an injury to the intima of veins, and it seems worth while to train one's self and one's assistants to avoid this as well as all other forms of unnecessary traumatization of tissues.

12. *Excess of Calcium Salts in the Blood.*—So many authors mention this as an etiologic factor that it may be important to consider it. So far we have paid no attention to this element.

It seems likely from our observations that in the future we will be justified in systematically adding the transfusion of 600 c.c. of whole blood to our preliminary treatment in a considerable proportion of cases belonging to a class which has in the past made up our list of deaths from pulmonary thrombosis and that the other precautions will be carried out with greater care.

It is likely that this will result in a considerable reduction in the death rate from post-operative pulmonary thromboses.

A short analysis regarding the etiology of the thrombophlebitis as shown in our eight tabulated cases is as follows:

Case I.—A man, forty-three years of age, who had an enchondrosteoma 21 by 11 by 7 cm. removed from the lateral surface of the left ileum. The wound was aseptic and there is nothing in the history which could serve as a predisposing factor, except the fact that ten years previously the patient had suffered from thrombophlebitis of the veins in both legs and that the venous circulation had been impaired ever since this occurrence. The wound was aseptic, but his thrombophlebitis must have lighted up again. Had this patient received careful preliminary treatment for several weeks, it is quite likely that the thrombophlebitis might have been prevented.

Case II.—A man forty-five years of age, giving a history of gastric ulcer complicated with cholecystitis and chronic appendicitis, had lost considerable in weight and was anæmic as a result of loss of blood from his gastric ulcer. The gall-bladder was thick, universally adherent, sacculated and filled with black viscid bile. The mucosa was granular. This gall-bladder was removed. The appendix was sacculated and universally adherent. In this case, the patient died six days after the operation from pulmonary thrombosis. This patient had anæmia and mild cachexia, also a great amount of disturbance because of the extensive operation and extensive adhesions. The operation lasted one hour and a half, consequently several factors were present which would account for the pulmonary thrombosis. A preliminary transfusion of whole blood and performing the operation in two stages, a gastro-enterostomy at the first stage and a cholecystectomy and appendectomy after the patient had fully recovered from the first operation, would probably have prevented the unfavorable result.

Case III.—A woman, thirty-three years of age, showed nothing in her history which would predispose to the development of thrombophlebitis. She had a normal cholecystectomy for the relief of gall-stone disease and perineorrhaphy performed with an anterior suspension of the uterus. She died from pulmonary thrombosis two days following the operation. It seems likely that some of the veins in the vicinity of the broad ligaments or rectum must have been injured during the operation. The case emphasizes the importance of protecting the veins.

Case IV.—A woman, forty-four years of age, with carcinoma of the rectum. This patient showed but very slight cachexia and was otherwise in fair condition. A simple colostomy was performed. The patient was under the influence of the anæsthetic less than half an hour, and there was nothing that one would reasonably expect to cause a thrombosis except that the mesentery of the sigmoid was transfixed and a strand of gauze and glass tube were passed through to keep the intestines from slipping back into the abdominal cavity. Evidently, a thrombus was loosened from one of these veins. Whether preliminary transfusion of whole blood might have prevented this, it is difficult to say.

Case V.—A patient sixty-five years of age had a simple suprapubic prostatectomy from which he made a very satisfactory recovery for fifteen days, when he died suddenly from pulmonary thrombosis. On the afternoon of the fourteenth day a phlebitis developed in the femoral vein, which undoubtedly accounts for the embolus which gave rise to pulmonary thrombosis.

Case VI.—A patient, thirty-three years of age, who suffered from a severe laceration of the perineum during delivery which was repaired immediately, died fourteen days later from pulmonary thrombosis. In this case there was severe suppuration of the perineal wound. Whether the infection from this source was responsible for the pulmonary thrombosis or whether the latter condition resulted from a loosened thrombus from the uterus, we have been unable to determine.

Case VII.—A patient, fifty-one years of age, suffering from gall-stones and cancer of the rectum with marked anæmia and cachexia, died of pulmonary thrombosis seven days after the operation, which consisted of a cholecystectomy and panhysterectomy. In this patient the anæmia should have been corrected by transfusion of whole blood and panhysterectomy should have been performed at the first operation and cholecystectomy after the patient had regained strength.

Case VIII.—A patient forty-three years of age, suffering from a floating kidney which could be moved over the greater portion of the abdominal cavity, from cholelithiasis and appendicitis. She had lost 35 pounds in weight previous to the operation. The operation performed consisted of cholecystostomy, appendectomy, and suturing the kidney in place. The gall-bladder contained a large number of stones. In this case, good judgment would have undoubtedly prevented the pulmonary thrombosis, because with the patient in this condition, the appendix and gall-stones should have been removed first and the floating kidney operated at a second operation.

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CLINICAL CONSIDERATION OF OSTEOMYELITIS

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CLINICAL CONSIDERATION OF OSTEOMYELITIS[1]

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IT has seemed worth while to consider osteomyelitis from the standpoint of the clinician because circumstances have favored us with an opportunity of observing an unusually large number of cases suffering from this affliction.

My observations began 34 years ago when I served as assistant to Professor Moses Gunn who treated a very large number of these cases. Following his death, I served as chief assistant to Prof. Charles T. Parkes for a period of 3 years, and after his death as chief assistant to Professor Nicholas Senn for a period of 4 years. Each of these surgeons had a great number of cases of osteomyelitis; hence my special interest in this subject.

In my own practice at the Augustana Hospital during the 20 years from January 1, 1899, to January 1, 1919, I have treated 301 cases of osteomyelitis, so that the following views are based upon the treatment and observation of a sufficiently large number of cases to be worthy of consideration. My assistant, D. W. Crile, served in France and England for a period of 3 years during the recent war where he had an opportunity of observing several thousands of cases of osteomyelitis due to gunshot and shell wounds and he likewise is interested in the subject.

Osteomyelitis is a disease, inflammatory in nature, involving bone and having its origin practically always in the medullary tissue, although at times it may originate beneath the periosteum (1), and also as Lejars (5) says: "Frequently, there are two foci; one, subperiosteal, and one, in the medulla."

Osteomyelitis may be subdivided into the acute infective type, the subacute infective (occurring during the separation of sequestra and including rarifying and condensing processes in the bone), and chronic osteomyelitis in which the infecting organism determines a further subdivision into pyogenic, tuberculous, or syphilitic.

As a matter of fact the division of infective osteomyelitis into an acute, subacute, and chronic stage, is purely arbitrary, and often can be accomplished only with the greatest difficulty, since the disease is a progressive one. However, as a general rule, the acute stage may be said to occupy the period when a general systemic reaction exists characterized by fever, toxæmia, an increased pulse-rate, intensive pain, always located near the affected part and generally being diffuse over the entire neighborhood. The subacute stage may be said to begin when the toxæmia has been overcome and suppuration still exists. The chronic stage constitutes that period in which the bone cavities exist.

It is possible for the acute stage to be absent, clinically, so that when first discovered the disease may be subacute or it is possible for both the acute and subacute stages to be negative clinically so that when first discovered, the chronic stage exists. This, however, is due to the fact that the early stages were looked upon as rheumatism, growing pains, or neuritis.

Clinically, the tuberculous and syphilitic forms should occupy a separate classification. They are chronic; although each may be subdivided into an early and a late stage of the disease. Their course, pathology, and treatment are quite different from that of the pyogenic forms so that they will not be considered at this time.

ANATOMY

The disease depends for its location and characteristics upon the fact that bone is a rigid and peculiar structure composed of a hard, sparsely vascularized cortex and a soft highly vascular core (the medulla), and a circumferential vascular covering, the periosteum.

All bones contain these three structures. However, they are present in varying proportions. The long bones such as the femur, tibia, fibula, humerus, and the bones of the forearm contain the greatest proportion of hard tissue and in these the medulla is a true core.

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[1] Read before the Chicago Surgical Society, February 6, 1920.

This core is transformed into a spread-out, flat structure in the flat bones but occupies the same relative position to the cortex. If one saws through a bone, the outer layers are found compact while the medulla is found to be composed of an interlacing of thin spikes and spicules having attachment to the cortex. The difference in these two portions is pronounced, the cortex being composed almost entirely of solid matter while the medulla contains large spaces between the spicules, in which there are fat, marrow cells, thin walled blood-vessels, and a considerable amount of blood. However, close inspection shows that the union between these parts is not an abrupt one and that it is often impossible to say at what point the marrow becomes the cortex. However, in the femur and humerus and to a less extent in the tibia a definite medullary cavity exists in adolescent and adult life—the shaft of the bone being hollowed out more completely than the ends. This cavity contains true medullary tissue: fat, lymphoid cells, and hæmoblastic centers. On breaking a long bone transversely, one is able to see that even the densest part of the femur is pierced by tiny canals each containing a blood-vessel and the larger ones containing lymphoid tissue. These canals are smallest in diameter directly beneath the periosteum where they are about 1/1000 of an inch in diameter and as one progresses toward the medulla, they gradually increase in diameter until at the place where the cortex merges into the medulla they are about 1/200 of an inch in diameter. In the medulla itself they attain a very much greater size (1½). These canals are nothing more than the tubes in which the blood-vessels lie and are called haversian canals after Clopton Havers an English physician of the 17th century. Each haversian canal is surrounded by a series of concentric columns of bone which columns are divided one from the other by concentric rings of single, little, thread-like processes which communicate from one cell to the other and with the central tube of the haversian canal. These cells are called the lacunæ and their thread-like processes are called canaliculi. The concentric layers of bone which are really fused into one column and the adjoining columns which are fused together making a continuous plate, are called lamellæ. Between the lamellæ and between the concentric groups of lamellæ, one finds here and there irregular spaces which evidently are a result of the absorption of hard bone. These spaces are called haversian spaces. Virchow (2) says that each of the cells occupying the spaces between the lamellæ is nucleated and Kolliker (3) is authority for the statement that some of the processes from these cells are connected with the periosteum and undoubtedly they also communicate freely with the blood-vessels of the haversian canals.

It will be seen from this survey of the structure of bone that neither the cortex nor the medulla should be considered a crystallized or an inanimate substance. As a matter of fact one has a better conception of the true nature of bone, if he considers it as a deposit of organized mineral salt between the spaces of a finely-branched system of blood-vessels. Not only is the entire bone permeated by canals containing blood-vessels and living cells absorbing nourishment from these blood-vessels, but lymphatics also most probably exist (4).

The periosteum is also very vascular and is a rather coarse, fibrous membrane particularly where it affords tendinous insertions. It can be divided microscopically into three parts; the one in immediate contact with the cortex of the bone, consists of strands of fibers containing quite a number of granular corpuscles particularly in the young animal. These corpuscles are precisely the same as those one finds bordering the haversian canals, and it is possible that they are similar to the bone corpuscles found in the lacunæ.

Surrounding this division of the periosteum is a layer of elastic fibers, and the outer part of the periosteum again becomes composed of white, fibrous strands containing many blood-vessels which ramify and prepare to enter the openings of the haversian canals of the cortex before they penetrate the elastic layer of the periosteum. These blood-vessels in the periosteum appear to have some muscular tissue in their walls but the vessels which enter the bone are devoid of muscle (except the nutrient artery). The blood supply of the bone comes also from nutrient arteries which generally enter the medullary cavity by a hole running obliquely through the compact cortex, and in the long bones the artery generally enters near the middle of the shaft. There are generally a few nutrient arteries entering the bones near their ends, but for the large part the foramina which one sees near the end of bones are for the emission of veins. There are two main nutrient arteries for the femur.

The course of blood through a bone. Arterial blood enters a bone through two routes, the most evident route being via a nutrient artery which after it reaches the medulla, sends blood both up and down the bone, rapidly dividing into an arborization, the branches of which are short, emptying quickly into comparatively large venous spaces. The other route of arterial blood is via the periosteal vessels, the arborization having already occurred in the periosteum—when following this route the arteries are lost track of almost immediately and capillary vessels conduct the blood through the haversian canals in which it may be said to become venous at once. It seems that this periosteal blood penetrates a very little distance into the bone, compared to the distance that the medullary prenutrient supply does. One can readily see how this comes about when one remembers that the haversian canals have their smallest diameter near the circumference of the bone. The blood issuing from the cut surface of live bone always exhibits the characteristics of venous flow, except when the nutrient artery itself is cut. For these reasons arterial blood, on entering the proper bony circulatory system, loses much of its impulse and becomes static. One may compare the entrance of blood into a bone with that of the entrance of a stream of water into a tank.

Foci of infection. Therefore, any organisms contained in the blood and brought by the blood to a bone, find their first opportunity to rest at the point where they enter the interosseous circulation. This point may be either directly beneath the periosteum or in the medulla at the point where the branches of the nutrient artery enter a blood-space. With the stasis of the blood, the bacteria settle and begin to multiply, undisturbed by a blood current. In this way bacteria which are not virile enough singly or two or three together to make a home for themselves in a more active tissue, are enabled to begin an infective process in the bone. Having multiplied to sufficient numbers, they excite a little inflammation in the delicate cells lining the blood space. These cells swell and leucocytes and fibrin accumulate, shutting off this blood space from the remainder of the circulatory system. This can occur easily because bone encloses the blood space in all directions except its entrance and exit, so that swelling must occur only toward the cavity of the space and cannot occur circumferentially. From this little focus toxins and young bacteria disseminate, reproducing and extending this same process. We know that this is true from clinical experience, because the primary focus in acute osteomyelitis is practically always in the shaft and corresponds with the arborization of the nutrient artery as a general rule, occurring most frequently at the places where stasis is greatest, e.g., on the diaphyseal side of the epiphyseal lines and at the cortex of the bone. At both these places the blood-vessels are narrow, and the blood current very sluggish.

It is true that in many cases there seems to be a simultaneous involvement of the subperiosteal region and the medulla but while this is possible it seems most likely that the process begins in one or other of these locations and rapidly extends through the communicating blood spaces from the medulla to the subperiosteal region, or vice versa. Lejars has noted the frequency of this occurrence and advises that whenever an accumulation of pus is found beneath the periosteum, it should be opened widely, even though no other indication exists—for a medullary abscess is undoubtedly present.

BACTERIOLOGY

Almost any organism may be found in osteomyelitis. By far the large majority of cases are due to the presence of the pyogenic cocci (6), and the staphylococcus is the organism most frequently found. Streptococcus in all its strains, the typhoid bacillus, the pneumococcus, the colon bacillus, the Klebs Loeffler bacillus and others, have all been found in this disease, so that it is quite evident that the disease is not dependent on a specific organism. Neither is there any proof that any particular strain of organism exercises a selective action for the bone marrow.

INCIDENCE OF DISEASE

Osteomyelitis occurs most frequently in the adolescent boy. In a series of 104 cases at the Copenhagen Hospital, it was found that boys were affected three times as frequently as girls, that the bones were affected in the following order: femur, 39; tibia, 31 and humerus, 9; fibula, 7; radius, 4 and ulna, 2. Our experience confirms this sequence.

It is interesting to note the greater frequency of the femur since this bone has more nutrient arteries entering it than any of the other long bones. The long bones are much more frequently involved than any of the others. The infrequent incidence of acute infectious osteomyelitis in the vertebræ is interesting when compared with the incidence of tuberculosis of the vertebræ, and in this connection we would like to point out that perhaps there are many cases of the disease in this region which are incorrectly diagnosed until spinal meningitis is manifested and as such proves fatal.

There is no doubt that trauma predisposes to the localization of the condition at the site of bony contusion. This is the true explanation of the greater frequency of the disease in boys, although the latter are also more subject to exposure.

The disease often follows exanthematous fevers, typhoid fever, pneumonia, acute pleurisy or the presence of a hidden focus of infection anywhere in the body. When following these diseases it is plainly the result of a hæmatogenous transportation of the germ. It is believed that the presence of infected tonsils, infected teeth, disease of the middle ear or sinuses, or chronic appendicitis, are often responsible for the origin of the bacteria causing this disease. In its acute stage, it sometimes is only a manifestation of a septicæmia or a pyæmia, and in these most serious conditions, multiple foci often exist. However, the disease does not necessarily indicate this grave condition.

PATHOLOGY

Early in the acute attacks the medulla is congested centering about the focus of infection. The periosteum overlying the involved region is hyperæmic, pinkish in color, and heavy with œdema. It feels tense and rubbery, but there is no actual pitting as one sees accompanying inflammation in the subcutaneous tissues. On separating the periosteum from the bone, bleeding is more evident than it is in the normal condition, indicating that the tiny blood-vessels which enter the haversian canals from the periosteum are dilated in their attempt to carry an extra amount of blood to the injured area. One notices this hyperæmia in the cortex itself in some cases when the marrow cavity is opened, for the congestion is quite marked. The normal fat tissue which ordinarily will not flow has a melted appearance and oil may even be seen oozing from the marrow spaces. At this incipient stage one may find no pus whatever, and it is during this time that operation accomplishes the most good, since if the medulla is well drained at this time, the infection may be checked absolutely so that medullary and cortical necrosis do not occur at all. One may discover this stage on the first or second day but as a general rule, abscesses are present within 24 hours of the onset. The abscess centers about the initial infarct and, if not seen until considerable pressure has been developed in the medulla, secondary abscesses will be found often at quite a distance from the primary focus. It is not at all uncommon to find the entire medulla of the bone full of pus. At this stage of the disease which may be encountered at any time after the first 12 hours, one frequently finds subperiosteal abscesses as well, which have developed from the medulla through the haversian canals to the subperiosteal region or vice versa.

Epiphysitis: The epiphysis becomes involved in 12 to 15 per cent of the cases and between the second and seventh day of the disease. When the epiphysis does become involved further growth of bone from the epiphysis may be arrested particularly, if actual separation has occurred.

As a general rule the disease is limited to the diaphysis, the epiphyseal cartilage acting as a block against extension of the process into the joints. And also the close adherence of the periosteum at the epiphyseal lines checks the extension of subperiosteal suppuration toward the joints. This in counterdistinction to the characteristics of tuberculosis. However, the joints proximal to the acute infection commonly show distention, the distending fluid being a protective outpouring of lymph into the synovia, and the fluid in these joints is very seldom infected. At times this fluid may even show traces of blood and the synovia are œdematous and hyperæmic.

Sequestration. After frank pus has appeared in the medulla, one hardly expects to prevent the necrosis which generally follows osteomyelitis. The inflammatory pressure which develops simultaneously with pus in the bones causes a shutting off of the blood and nourishing lymph to certain parts of the involved bone. Thus these parts die and after varying lengths of time are separated from the living parts. The separation of the delicate medullary bone occurs more quickly than does cortical sequestration. Thus medullary sequestra may be loosened after 2 weeks while the cortical sequestra generally take from 4 to 8 weeks in separating. The separation seems to be accomplished through the activity of certain marrow cells termed osteoclasts whose function it is to destroy all unnecessary bone. However, it seems that the presence of pus itself has some solvent action upon dead bone and this action is demonstrated by the gradual disappearance of small sequestra which are constantly bathed in pus. This solution of sequestra is a long and slow process which may be aided by chemical stimulation but surgical removal of sequestra after separation is our practice.

Character of pus. As the acuteness of the process decreases, the character of the pus changes gradually, until in the subacute and chronic stages the pus becomes a thin, serous fluid lacking the milky rich appearance of the pus found in the acute condition. The very initiation of the process, however, is generally accompanied by a very thin, almost clear exudate, and this is particularly true when the offending organism is the streptococcus.

Repair. Reparative processes begin simultaneously with the formation of sequestra which may be single, multiple or the entire shaft may become a sequestrum. Inflammation stimulates the bone-producing mechanism, and it is not long until new bone begins to appear beneath the periosteum. It seems that this does not come from the periosteum itself but from bone element left clinging to the periosteum and nourished by the vessels of the periosteum. After 3 or 4 weeks, the periosteum begins to have a brittle feel much like the crackling of delicate tissue paper, and gradually the layer of new bone nourished by the periosteum assumes a definite thickness and gradually loses its property of being molded until after 8 or 10 weeks a definite shell of new bone surrounds the old dead bone. This new involucrum is poor in quality. It is honeycombed with spaces through which pus escapes from the neighborhood of the enclosed sequestrum or sequestra. There may be only one small hole through the involucrum but where multiple sequestra are contained, many cloaca are found and often the new shell of bone is so fenestrated as to resemble a very imperfect lattice work.

The new involucrum may be very imperfect in its reproduction of the original bone. Particularly is this the case when entire portions of the shaft have been destroyed and the limb has not been kept in its normal shape by orthopedic appliances. This most often occurs in the upper arm and thigh since in these parts there is only a single bone. In the leg and forearm where a second bone generally retains its shape, deformity does not so readily occur.

New bone is also formed from the medullary region, but this bone is not so important pathologically since from its position it cannot surround dead fragments, and therefore is more homogenous and of better quality than is the subperiosteal bone.

Granulation tissue is more generally found growing from the medullary region than from the periosteal region, and it seems that the chief efforts from the core are directed toward the removal and destruction of sequestra and bacteria, while the efforts of the circumferential tissues seem to be directed toward the reproduction of supporting bone. So far as the pathology of the chronic stage is concerned, it makes no difference whether the acute process has been cut short by surgical intervention or whether nature has accomplished the overthrow of the acute infection. In either case the successful outcome will have been accompanied by the creation of an exit for the pus, so that in the later stages one sometimes finds sinuses leading from the sequestra to and through the skin. If these sinuses are the result of the spontaneous evacuation or of insufficient incisions through the periosteum in draining the abscesses they may be very long and devious. An abscess arising in the medulla at one end of a bone may not find egress from the interior of the bone until it reaches a point quite a distance from its origin. Here it breaks through the cortex to the subperiosteal region where it may travel still further from the original focus before it makes exit through the periosteum into the fascial planes overlying. This is most likely to occur near the insertion of a tendon and from this point the pus generally travels along the tendon sheath toward the surface where, after a superficial abscess is formed, rupture occurs. Frequently the spontaneous sinus has a direct course to the surface and when this is true it resembles the sinus resulting from surgical drainage. In either event the sinus in the chronic stages is lined by granulation tissue. The granulations which spring from the interior of the involucrum together with those that line the sinus pour out a thin chronic discharge. Often the deeper granulations assume characteristics which have led French writers to call them "fongosites." These "fongosites" are overgrown, poorly nourished, œdematous masses—when cut they do not bleed as healthy granulation tissue does. They have a sickly gelatinous appearance and almost always indicate the presence of a sequestrum. When the sequestrum has been dissolved, discharged, or removed, the cavity of the involucrum fills slowly and incompletely with these granulations depending from the lining membrane of pseudo periosteum. These involucral cavities persist for great lengths of time and seldom fill in with healthy tissue. As time goes on the involucrum becomes very dense, and this is particularly true where there have been multiple small cavities and sequestra while the bone at a little distance suffers an atrophy. These two conditions may be seen in the same bone or one or the other may be present alone. The sclerotic condition is termed condensing osteitis while the other is rarifying osteitis.

The pathology of the chronic condition which we have described is generally absent altogether following thorough primary surgical interference, but these changes are so frequently present they must be described.

In considering the pathology of this condition, one must also remember that the overlying soft parts may suffer changes dependent upon infection, disuse or deformity, and likewise contiguous joints may suffer from actual infection or secondary reactions.

SYMPTOMS

Intense pain is the most striking symptom of acute osteomyelitis—pain so severe that the patient's perception of one's intention to touch the limb elicits agonizing shrieks. In severe cases the vibration of a bed from people walking near by causes pain and the slightest motion of the affected limb is intolerable. The pain may be preceded by, but generally precedes, a high fever, a rigor or a succession of rigors, general toxæmia, and sweating. Soon the affected limb becomes swollen, heavy, and inflamed; the swelling is generally diffuse, as when the femur is involved the whole thigh becomes tense, red and tender. In the leg or forearm the œdema is apt to be most pronounced over the affected bone. The joints are usually not swollen nor tense in the first few hours but may rapidly fill with serum and result in the appearance of an arthritis; in these cases the limb may be held in the typical positions of the various arthrites.

The temperature rises acutely to very high levels 103° to 105°, and is of a continuous type with little variation between morning and evening. The patient is generally unable to sleep. The pain is not definitely localized but involves the entire limb. The pain becomes worse on lowering the limb, as one would expect since in this position congestion is increased and, therefore, pressure on the nerves is increased.

When the bone is involved subcutaneous tapping on it at a distance from the focus will cause pain at the involved area. In case of an abscess or before an abscess is formed, induration may be found over the site, particularly when the subperiosteal focus is present.

In the less acute types the pain is of a constant character, described as an aching, located in the bone, and resembling the so-called growing pains. These cases occasionally show a slight febrile reaction, present one day and absent for an interval. Sometimes the patient will refuse to use the limb as after use, the pain increases. The subacute type may or may not be painful. There is generally an occasional spell of fever with malaise in the part. This spell may be precipitated by changes in the weather or overexertion. The surface of the bone may show nodules and irregularities.

The chronic type without sinuses is seldom discovered in boys and girls and in older people often simulates and is probably diagnosed as chronic rheumatism. It is this type that includes the circumscribed bone abscess and bone-cysts. The chronic stage of the acute disease is almost always made evident by the presence of a discharging sinus.

DIAGNOSIS

Acute infective osteomyelitis must be differentiated from acute rheumatic fever which can usually be accomplished by noting that the affection is extra-articular. When contiguous joints are swollen secondarily, however, the differentiation is not easy. When this condition exists, tapping over the bone at a point farthest from the joint, may cause pain in the bone, while in an acute rheumatic joint, such tapping may be painless *unless the joint be moved.* The presence of a single synovitis argues against acute rheumatism. One finds too that the skin overlying the joints is less red and œdematous when the synovitis is secondary to osteomyelitis. The general prostration, while it may be great in both the diseases, is often greater in osteomyelitis. Sometimes the joint contiguous to the osteomyelitic bone can be moved painlessly, but this is rare; one must always differentiate between acute osteomyelitis and an early stage of infantile paralysis. At times this is very difficult. The presence or absence of stiffness of the neck is very important in this differentiation, and whenever two limbs are involved, one can safely rule out osteomyelitis, as the disease rarely begins with a double focus except as evidence of a general pyæmia. The acute arthritis of infants generally occurs in the hips and knees and is most often found in nursing babes and may be associated with a gonorrhœal ophthalmia or vaginitis (8). In very young children one must always bear in mind the possibility of the presence of scurvy, which can be readily recognized because it affects many joints.

Acute arthritis deformans, especially when occurring in children, may be very difficult to differentiate. Generally the arthritis is multiple, however, the prostration not nearly so sudden, the temperature not nearly so high, and the joints less tense. All these conditions, however, can be excluded by the exact localization of the process outside the joint, and generally on the diaphyseal side of the epiphysis. The condition should not be overlooked in its earliest state when it is usually considered a strain or sprain or contusion, since a history of trauma is frequent.

The X-ray is of little or no value in the diagnosis of the early acute stage except in a negative way, since it may confirm the presence of periosteitis, tuberculous or syphilitic disease, or fractures; when medullary abscess formation has occurred, an excellent X-ray plate may demonstrate the condition but the diagnosis should be confirmed by one who is thoroughly familiar with the shadows seen in this condition, since they are often very faint and illy defined. The later stages of the disease when bone cavities, cysts, and sequestra exist are readily detected by the X-ray.

PROGNOSIS

The prognosis of the acute disease is always grave. When death occurs it is generally during the acute condition, and one finds pyæmia, infarcts in lungs, kidneys, liver, brain, and vegetative conditions of the circulatory system as well as multiple foci of infection. These conditions may be the result of an unattended osteomyelitis but often are concomittant evidences of hæmatogenous infection from some common area.

Early diagnosis with immediate surgical treatment modifies the gravity of the condition considerably, but one should never predict that a limb with unimpaired function may result.

Often when the focus is virulent and extensive and early treatment has been neglected, when the general reaction is extreme, (the type of case which appears to have been "hit by a sledgehammer"), amputation has been recommended as offering the best hope of recovery. In our experience this extreme measure has never seemed indicated, although patients have frequently been sent to Augustana hospital for this last hope. In these cases it has always been possible to change the condition by laying open the periosteum and overlying soft tissues, applying an enormous hot moist boric acid and alcohol dressing covered with a large rubber cloth which serves the purpose of retaining heat and moisture and at the same time acting as a splint, and by applying a therapeutic lamp over this dressing. In a small group of very severe cases it is advisable not to chisel open the medullary cavity of the bone at the primary operation.

With early and thorough surgical drainage one may not expect the process to spread into the neighboring joints, even though synovitis already exists in them. When the focus is close to the epiphyseal line, separation of the epiphysis may follow with the resultant loss of the power of growth from that end of the bone.

At times the extreme virulence of the disease results in the destruction of the osteogenetic powers of the tissues so that the bone will not regenerate. Rarely, the opposite result obtains, i.e., bony overgrowth follows the chronic type.

With early surgical intervention within the first few hours of the disease and in the absence of pyæmia, the focus being well away from the epiphyseal line, one may expect recovery with a functioning limb even in extremely serious cases after a long period of disability and with the remote prospect of several secondary operations for the removal of sequestra and for the obliteration of the sinuses.

TREATMENT

Acute infectious osteomyelitis does not seem to have been recognized until comparatively recent times, the explanation probably being that the abscesses finding their way to the surface, obscured the deep pathology and the cases were treated simply as very grave attacks of boils.

The treatment of the acute condition so commonly practiced until recently with poultices, blisters, fomentations, sedatives, cupping, antipyretics, salves, and ointments or manipulation and the healing arts, should be most heartily condemned. The only proper method of treatment is surgical drainage, splitting and reflecting of periosteum over the entire distance and at least 2 centimeters beyond and on each side, and opening the medullary cavity freely in the area involved. Combined with or following this, the part should be immobilized by splints so arranged that dressings can be done without disturbing the splint. Fomentation in the form of hot moist dressings seems a valuable adjunct to this procedure and any of the above mentioned remedies may be employed as accessories without harmful effect except treatment by manipulation. The use of therapeutic lights over the limb is a very valuable adjunct to drainage as they supply heat without the necessity of disturbing the limb. It also seems that the heat waves produced by means of electric light are more penetrating than those produced by the application of ordinary fomentations, hot water bags, and electric pads.

OPERATION

The patient is anæsthetized, the limb is cleaned and painted with tincture of iodine. The incision is made down to the periosteum avoiding the arterial regions and the nerve-trunks and placing the incision so that it will drain in a dependent fashion without pocketing. The periosteum is freely incised in a longitudinal direction, and if it is not already separated from the bone by the presence of a subperiosteal abscess, it is raised by scraping it from the bone by a sharp rugine such as Ollier devised. The blunt periosteal elevator should not be used nor should the periosteum be stripped roughly from the bone. A sharp, thin bladed chisel serves the purpose admirably, handled with great accuracy and gentleness.

Rough treatment would result in leaving the osteogenetic elements on the bone and would leave the periosteum impotent to produce new bone. A hole is now made through the cortex with a trephine or a drill or by chisel and mallet, great care being taken to avoid undue jarring of the bone before the operation is begun or during the operation. It may be necessary to make several holes through the cortex although this is rarely necessary if the point of greatest tenderness is carefully located. In the very early stages one may find no frank pus whatever but the marrow will be oily, serous and œdematous-looking. When this condition or the presence of pus is discovered, a large slab of cortex should be removed, leaving the remaining bone in the shape of a trough. One should chisel sufficient cortex away in both directions from the focus that he may be sure that no secondary focus remains undrained.

The further advantage of this procedure is that any incipient focus, too early to be detected grossly, will be nipped in the bud and will not progress to a destructive stage. The marrow or the exposed area should be removed with a curette and the walls of the cavity remaining may be washed with an antiseptic solution. For this purpose carbolic acid (5 per cent) seems very efficacious. In virulent infections, pure carbolic acid may be used, applied on a cotton swab and allowed to remain from 2 to 5 minutes. After this time it should be diluted with alcohol and the cavity thoroughly washed out with alcohol (95 per cent). In place of using carbolic acid, alcohol alone may be used or ether may be used and of late Dakin's solution has come into favor for this purpose. Tincture of iodine is excellent. The use of various antiseptic pastes does not seem so successful in the treatment of the acute stage, although the bismuth, iodine, paraffin paste seems to have a favorable effect. The cavity may be packed with iodoform gauze or plain gauze to prevent the accumulation of a blood clot after operation. The presence of clots during the acute stage is dangerous and may lead to continued suppuration. The use of Carrel's treatment seems to give good results. Stewart and McCurdy declare that 3½ per cent iodine is the best antiseptic and that packing interferes with the formation of a blood clot, in this way interfering with bone repair. It is most likely that the cases in which a blood clot is desirable, are not at all the type of case that we are considering since the presence of blood clot in this class of cases almost invariably leads to further septic developments. The wound is left open.

Rosenberg says that streptococcus and pneumococcus epiphyseal suppuration often heals spontaneously and that the treatment in nursing infants should be limited to the opening of abscesses (10). He may, however, have confused the acute arthritis found in infancy with an acute osteomyelitis. One should hesitate in making a diagnosis of osteomyelitis in suckling infants for this reason. In my own cases of osteomyelitis in infants the results have been amazingly good following simple incision.

It seems that Lejars and Robert LeConte (11) agree that it is never expedient to incise the periosteum only but that in all cases of periosteitis in the adolescent, it is wise to expose the medulla. If no medullary pus is found little harm has been accomplished while if a medullary focus has been neglected great harm may ensue. My experience has borne out this plan except in the very violent cases described above. (A. J. O.) LeConte favors the early removal of all bone and marrow involved and says that regeneration will occur if operation has been done early. This corresponds with the work done by E. H. Nicholls, of Boston (12), who, writing in 1904, thought that the periosteum itself deposited new bone after this operation. There can be no doubt that new bone is generally of good quality, reproducing the shape and function of the bone which has been removed. This is particularly true before the ossification of the epiphyses. The bone-forming elements which remain attached to the periosteum are very active at this time of life. It would seem that in order to understand these results, one must believe that inflammation of the bone loosens the bone-forming elements from the periosteum.

Our observations have convinced me that it is never proper to remove the shaft of a bone during the acute stage of osteomyelitis before an involucrum has been formed, because the resulting arms and legs have been infinitely superior in all cases where there has been a late removal of the sequestra.

Based on the experience of handling many thousand cases of traumatic osteomyelitis during the great war, it would appear that when complete subperiosteal excision of a section of shaft is done within a few hours of inoculation, regeneration occurs with more difficulty and more often fails to occur than if the same operation is performed later. In traumatic osteomyelitis, excision of a section of shaft bone after inflammation has manifested itself by congestion and thickening of the periosteum, is hardly ever followed by failure of regeneration by the formation of subperiosteal callus. This is particularly true where the bone-scraping technique of Ollier has been followed as described by Leriche (13). When this technique has been skillfully employed, even before the periosteum is inflamed, regeneration almost invariably occurs. These facts argue that the scraping of the bony cortex and inflammation in the same region result in leaving bone-forming elements adherent to the periosteum.

This explanation of the question makes it clear that subperiosteal resections of bone in acute infectious osteomyelitis are not to be feared provided operation is never performed in this condition before the appearance of inflammatory symptoms. This simple fact, i.e., that inflammation always preceded operation in this condition explains the regenerations which Nicholls so fortunately enjoyed but which he attributed to the periosteum itself.

The work of Nicholas Senn, on the other hand, based on the classical experiments of McEwen (14), gave remarkably favorable results. He did not favor the excision of the entire shaft at an early stage but advocated the operation providing radical drainage, leaving a shell of bone to be dealt with as indicated at a subsequent operation. Nicholls agrees with this idea when the disease is located in either the femur or the humerus, since these bones cannot be excised without considerable deformity and shortening resulting. In the case of one of the bones of the leg or forearm, its fellow serves to maintain the length and shape of the limb so that this element does not enter into the question so seriously as it does in the thigh and arm. Taking all things into consideration, it seems that the best treatment of the initial stage of the disease is immediate incision through the periosteum, thorough exposure of the medulla, leaving enough supporting cortex to prevent deformity and in such a shape as not to interfere with drainage and leaving a layer of bony scales adherent to the reflected periosteum, the disinfection of the exposed tissues with tincture of iodine, the packing of the cavity with iodoform gauze to be removed on the second or third day, and the provision of free dependent drainage.

This treatment should be instituted immediately on making the diagnosis. One must be careful to avoid the epiphyseal cartilages in doing the operation, since injury to this area results in a hindrance to further bone-growth from the injured end of the bone. When the infective process itself involves the epiphysis there is no other course to adopt, except that of thoroughly clearing away all diseased tissue, since if the surgeon be hindered by timidity, it is possible for the process to extend into the contiguous joint, when amputation may result. It is wise to mention the possibility of the subsequent shortening which one anticipates so that the patient and his relatives may know what to expect.

Supplementing this operative treatment, the limb should be immobilized and local heat supplied, either as fomentation with hot boric acid and alcohol dressings or by using an incandescent lamp so arranged that its heat is directed on to the limb, or a combination of the two methods, the lamp tending to maintain the heat of the moist dressing. The patient should be freely purged and for this purpose, castor oil excels all other drugs. The patient should be given an abundance of good water to drink and often by giving water in the form of lemonade, aerated waters, mineral waters or weak tea, larger amounts may be drunk than if only plain water were offered. Large amounts of water provoke a diuresis and this, coupled with the purging, tends to increase the excretion of the toxins which the patient has absorbed from the diseased bone. With this treatment, the infection is rapidly overcome and no further extension of the process should occur.

The after-treatment consists in the removal of the gauze packing on the second or third day, or sooner if the temperature does not fall the day after operation. It is seldom necessary to insert rubber drainage-tubes, if the case has been diagnosed and operated on in the early hours of the disease. However, if the case has not reached the surgeon until the entire medullary cavity is filled with frank pus or even after the pus has begun to burrow in the soft parts, it is wise to remove the packing after 12 to 24 hours and to replace it by one or several drainage tubes, and this type of case will do very well when treated by Carrel's method, with frequent irrigations through many fine tubes each one leading down to the bone cavity. The wound should be kept open while it heals by granulation from the depths. It is occasionally possible to suture these wounds at their primary operation, leaving a corner of the wound open to permit removal of the gauze pack and for the insertion of a drainage tube if necessary. If doubt exists as to the wisdom of closing the wound at once, it should be left wide open and closed at a second operation after healthy granulation tissue appears. This should be postponed, however, until the wound has become free from infection which can be determined by examining the secretion microscopically. One must bear the fact in mind that the presence of bacteria is proof of infection, but that the absence of bacteria microscopically is not sufficient evidence to prove that a wound is sterile.

The cases which are not seen by the surgeon until actual necrosis of a section of the shaft or for that matter the entire shaft present greater difficulty. It is in these cases that immediate excision of the necrotic bone should never be practiced.

I have been impressed with the importance of this rule many times in cases in which it seemed impossible to have any portion of the shaft of a long bone restored to normal. In these cases we employed the treatment described above of splitting all of the soft tissues longitudinally down through the periosteum for a distance of 2 to 5 centimeters beyond each end of the area apparently infected and elevating the periosteum from its attachment to the bone for a distance of 1 centimeter each side of this incision and then applying hot, moist, boric acid and alcohol dressings and placing a therapeutic lamp over all. It has been surprising in many of these cases how small the total loss of bone has been ultimately. The bone which seemed hopelessly dead in many instances seemed to act in the capacity of a bone graft, being replaced to the greatest extent by new bone so that ultimately only a very small portion of the bone was lost.

In one case, a girl of 14, in whom the attack was unusually violent, an incision over the entire dorsal surface of the first metatarsal bone showed this structure black from end to end ready to be removed entirely. The treatment described above was employed and in 12 weeks the wound was completely healed without the loss of any portion of the bone. The entire bone served as a bone graft. The healing has been permanent. In my experience this observation has never been repeated to the same extent but a sufficient amount of bone has been saved in a large number of cases to convince me that much value should be placed on this plan of treatment.

The important point to be gained comes from the fact that this treatment directs the lymph stream away from the substance of the bone so that there can be no advancement of the pathologic process, while on the other hand all of the natural forces can proceed with the work of restoration.

Whatever cannot be repaired by nature can be accomplished surgically later on at leisure when the patient has recovered from the acute condition and when the element of sepsis has been eliminated and the surgeon has to deal only with end-results of the disease.

CHRONIC OSTEOMYELITIS

The experience of the war has been of great value in furnishing experience in the treatment of chronic osteomyelitis although conditions are not exactly parallel. The important lesson universally learned corresponds with the experience of the few civilian surgeons who had a large experience with chronic osteomyelitis before the war, namely: (1) that in order to succeed one must remove absolutely all dead substance. In war surgery this means foreign substances in addition to sequestra which are alone to be considered in civil practice. (2) Provision must be made for filling the defect after all foreign bodies and dead bone has been removed and every portion of the remaining cavity has been thoroughly freed from infectious material.

Methods of closing the defect. My earliest experience with these cases was as an assistant of Moses Gunn in whose clinic we treated a great number of cases of chronic osteomyelitis.

After removing all sequestra and producing a smooth, cavity he tried to obtain healing from the bottom by keeping the external wound open by means of a paraffin plug.

This plan proved very satisfactory although somewhat tedious. I also had an opportunity of observing many cases treated in the clinic of Charles T. Parkes who was my surgical chief following the death of Professor Gunn. The same plan of treatment and the good results continued.

For a number of years following this experience, I assisted Nicholas Senn in the treatment of many of these cases. After thoroughly removing all sequestra and infectious matter and smoothing the cavity in the bone, he chiseled away a sufficient portion of the involucrum to permit the edges of the wound to unite without the slightest tension.

Then the cavity was carefully desinfected with 5 per cent carbolic acid and thoroughly dried; then finely cut, decalcified bone chips, which had been preserved in 1:1000 corrosive sublimate solution, were dried and sprinkled with iodoform powder and carefully packed into the cavity in sufficient quantity to fill the cavity barely full. Then the edges of the wound were carefully sutured so that the coaptation was perfect. A very large dressing and immobilization splints completed the operation. The results were excellent. The reason why the method has not received more extensive adoption lies in the fact that few surgeons work with sufficient accuracy to carry out every detail of this procedure which is necessary in order to prevent the breaking down of the implanted graft. Moreover, the simpler method introduced by Max Schede about the same time brought identical results. Moorhof introduced a plug about the same time which we used with equally good results in a few cases but which we abandoned again because the results seemed no better than with Schede's method.

This method consists in the steps described in connection with Senn's method to the point of filling of the cavity, the technique then being as follows:

The cavity is left empty and the wound is closed by means of a double row of continuous catgut sutures the first row acting as tension sutures and the second row as coaptation sutures. An Esmarch constricting bandage is left undisturbed until the very large dressing supported with a number of splints has been applied and the patient has been returned to his bed with the limb elevated in order to prevent the cavity to fill moderately with a blood clot which may remain undisturbed because of the character of the dressing until it has become thoroughly organized.

In each of the three methods described last the element of absolutely preventing any disturbance of the clot filling the cavity in the bone is of the very greatest importance. The failure to appreciate this fact has resulted in most of the bad results following the use of these methods.

In cases in which there is not sufficient tissue to cover the cavity the method described by Emil Beck of carrying what skin is available toward the bottom of the cavity without tension has given very satisfactory results.

In a number of cases in which the healing has been too slow, we have covered the granulating surface with Thiersch grafts. It is amazing to see how these troughs will fill up after covering the granulations with Thiersch grafts. Occasionally we have loosened long lateral flaps and have united these in front over the defect in the bone and then we have covered the defects on each side by means of Thiersch grafts.

RECURRENCE

In our cases recurrence has seemed to be due most commonly to the fact that during the primary treatment the source of infection was overlooked so that the patient suffered from a re-infection rather than a recurrence in the usual sense of the word.

Many of these patients state that they had a cold or a sore throat or a toothache just before their osteomyelitis recurred. Upon making a careful examination one finds a buried tonsil containing an abscess or an abscess at the root of a tooth or some other focus of infection. For thirty years we have removed these infected tonsils and roots of teeth in many cases in which recurrence had occurred, and the patient has repeatedly remained free from trouble for a number of years.

Trauma is another common cause of recurrence. Apparently some slight injury determines the return of infection to a bone that has previously been the seat of osteomyelitis.

Sugar. Patients consuming large quantities of sugar are subject to the development of furuncles and carbuncles and occasionally this seems to be an element in determining the occurrence of recurrent osteomyelitis.

Cold and exposure. We have seen a number of recurrences following exposure to cold and wet. In these cases, however, there has been an infection of the tonsils, the sinuses or the air passages.

We have not been able to associate osteomyelitis with the occurrence of intestinal disturbances although *a priori* one would suppose that this might be a source of infection.

CONCLUSIONS

1. An early concise diagnosis and immediate surgical treatment is of the greatest importance.
2. The operation should invariably consist in splitting the periosteum for a distance of 2 to 5 centimeters beyond the area of pain upon pressure in the bone in each direction.
3. The periosteum should be loosened from the bone for a distance of 1 to 2 centimeters on each side of the incision.
4. In extremely severe cases this should be the extent of the primary operation.
5. In less severe cases ultimate healing can be hastened by carefully opening the medullary canal at the point previously located because of pain upon pressure.
6. Care should be employed to prevent traumatizing the tissues by rough chiseling.
7. Moist hot antiseptic dressings with fixation of the extremity and with the use of electric light treatment increases the comfort and facilitates healing.
8. The shaft of a long bone should never be removed until a good involucrum is formed.
9. In late cases or in secondary operations upon cases treated as above in the acute stage, every particle of dead tissue must be removed.
10. At this operation some definite plan must be carried out to facilitate closing the defect.
11. Skin grafting is of great value in many cases.
12. Local foci of infection such as abscesses of tonsils or teeth or sinuses, should invariably be eliminated at once upon undertaking the treatment of patients suffering from osteomyelitis.

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CANCER INFECTION*

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As far back as medical history extends there have been certain diseases which have been looked upon and feared by the public because they have been supposed to be transmissible from one person to others in some way. Their mode of transmission has been explained in many cases since their etiology has been determined by finding certain microorganisms which could be isolated, grown upon culture media, and which when inoculated upon healthy animals or upon human beings produced the identical disease from which the patient suffered from whom the original microörganisms were taken. In this manner diseases which had for centuries been looked upon as contagious or infectious were definitely proved to be so. Other diseases, like measles, scarlatina, and smallpox, in which it has not been possible to isolate the specific microorganisms, are so evidently due to infection that no one is in doubt about this fact.

For many years the public consciousness—often called superstition—has recognized the infectiousness of tuberculosis, leprosy and cancer, while many of the most learned members of the medical profession have claimed the contrary because the infectious character has not been demonstrated on account of technical difficulties. These have fortunately been cleared away in the case of tuberculosis and leprosy, but not as yet, so far as general knowledge is concerned, in the case of cancer.

Had Robert Koch or some other investigator not demonstrated the tubercle bacillus, there is no doubt but what hundreds of thousands of healthy persons who are now protected against tuberculous infection would still be exposed to this danger precisely as they are exposed to the danger of infection from cancer to-day. This is due to a simple error in logic. We disregard the popular prejudice because we cannot demonstrate a scientific basis for this prejudice instead of accepting the popular prejudice as being in all probability based upon observation and knowledge which were lost during the dark ages, but which were well founded upon fact during the ages which preceded this period of ignorance. We say because we cannot find the agent of infection therefor it does not exist, instead of saying our ignorance and incompetence and lack of skill and insight have prevented us up to the present time from discovering this agent, hence we must approach the question always from a new angle until we will ultimately succeed in establishing conditions which will enable us to determine this cause.

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We may say that the appearance of cancer is preceded so constantly by long-continued local irritation, as in smoker's cancer, the cancer of betel-nut chewers, that of paraffin workers, chimney-sweeps, etc., that we are justified in considering this irritation as the actual cause. What would we think of a farmer who would fail to put seed on his land because he has observed that the soil has to have a certain degree of preparation before a certain crop can grow? In the same way we have observed that cancer will develop very constantly on the proximal side of the pylorus and on the distal side of the ileocecal valve, while it will develop only rarely between these two points. The fields in which it will develop contain substances acid in reaction, while the intestinal contents in the intervening portion are alkaline. The farmer knows that he can grow rye in an acid soil but in order to produce a growth of alfalfa or red clover the soil must be alkaline. In either case, however, he must sow the specific seed which will produce the growth desired.

We know that it is an easy matter to transplant carcinoma nodules from one animal to another but that if these nodules are exposed to a temperature of 160° F. no growth will occur. This may mean that the tissue itself cannot live in a temperature higher than this or it may mean that this is the limit for the life of the infectious material causing the cancer.

For many years the fact that the few experiments in transplanting human cancer from one person to another have failed has been looked upon as proof for the non-transmissibility of cancer from person to person. Of course, this has been long disproved by animal experimentation, but it serves as an example of the harm that can be done by concluding that because one has failed to prove a fact therefore it has been disproved or because one has not been able to do it therefore it cannot be done. For years the failure of attempts to transplant cancer or to inoculate cancer from one person to another was used as an argument against the infectiousness of cancer. This would not be of much importance were it not for the fact that in the meantime, while we are waiting for some person who is competent to discover the cause of infection, the public are encouraged in exposing themselves to this infection, against which popular prejudice might otherwise protect these persons.

A study of the literature shows that less than thirty years ago Langstaff ("Studies in Statistics," London, 1891) and many others proved statistically and to their minds scientifically that tuberculosis is not infectious or contagious because in many families the husband or wife suffered and in many instances died from the disease, the other partner remaining free from it. This identical argument is being advanced in the case of cancer. The fact that the soil must be proper as well as the seed in order to secure growth is being overlooked in the case of the cancer as it has in every disease which has been classed as infectious or contagious by popular belief or prejudice.

The experiment of Miss Slye with white mice shows conclusively that certain animals are more susceptible to the development of cancer of heredity than others.

TABLE I

India Per cent. of Carcinoma deaths		*Japan* Rate per 100,000 population
0.0	Stomach	52.3
0.0	Œsophagus	12.4
6.0	Liver	7.3
8.0	Buccal	2.3
1.4	Larynx	2.3
13.2	Skin	0.8
13.0	Breast	0.6
6.0	Uterus	11.0
18.0	Male genitalia	0.?

TABLE I.—Shows the difference in distribution of cancer to different parts of the body in nationalities whose habits of living are very different, the parts of the body exposed to contact with filth being extensively infected with cancer.

TABLE II

Total Cancer Mortality per 100,000

Copenhagen	161.3
Berlin	133.5
Amsterdam	116.7
London	111.7
Rome	100.5
Moscow	94.8
Sydney	90.1
Petrograd	85.6
Buenos Ayres	85.1
Chicago	78.9
New York	77.1
Tokio	73.6
Osaka	55.9
Calcutta	11.7

TABLE II.—Shows the number of deaths from cancer per 100,000 of population in different important cities.

TABLE III

Hawaii, 1911-1913. Rate per 100,000 by race and organ.

Total		Breast	Face	Int.	Stomach	Uterus
Japanese	19.8	0.0	0.0	12.1	57.6	18.2
Chinese	26.5	0.0	8.3	0.0	50.0	16.7
Portuguese	58.0	3.7	0.0	0.0	40.8	7.4
Hawaiian	93.8	13.7	0.0	2.0	27.5	29.4

Asia

Ceylon	5.6
Hongkong	8.1
India	11.7
Penang	10.3
Japan	60.2
Shanghai	55.3

TABLE III.—Shows death rate per 100,000 by race and organ.

TABLE IV

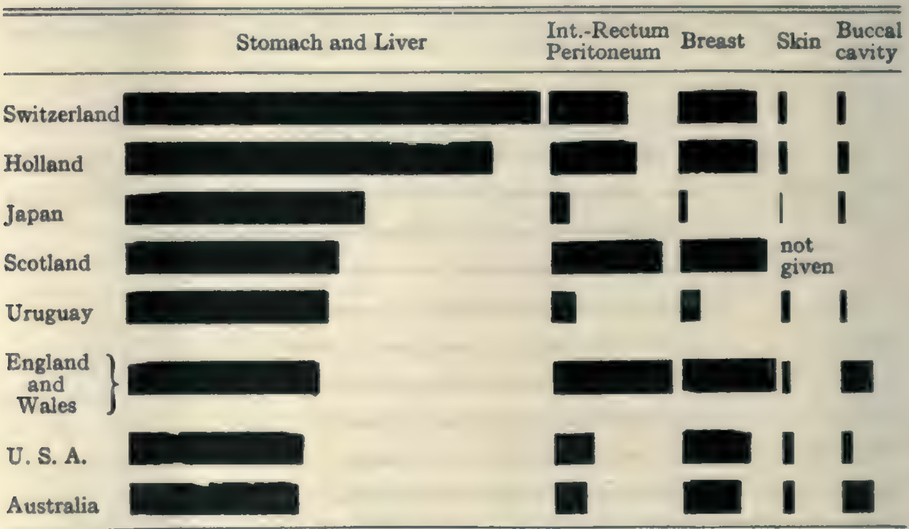

TABLE IV.—Shows the relative frequency of cancer in different organs for various countries.

These tables were constructed from statistics taken from the volume published by Frederick L. Hoffman, statistician of the Prudential Life Insurance Company, who has given the subject an enormous amount of attention.

The fact that whole families of human beings have died of cancer has been used as an argument in favor of infection because living together they are all likely to be exposed to the same sources of infection. The same has been claimed for houses in which successive families have died of cancer.

On the other hand, these conditions have been ascribed to coincidence or to hereditary tendency.

The fact that surgeons do not generally die of cancer has been given as an argument aganst infection. If one observes the care with which surgeons guard against possible infection of any kind this argument at once loses all weight.

The fact that we find the same histologic structure of metastatic cancer that we find in the primary growth has been used to discredit the infectious theory. Metastases must consequently be transplanted particles of tumor tissue and not infections at a distance from the original growth. If the cause of cancer is an infection apparently it sets free living cells, some of which will continue to grow after being carried to a distance by the lymph-stream or the blood-stream.

There seems to be an exception in case of Paget's disease of the breast, in which one may find squamous epithelium in the original cancer about the nipple, columnar epithelium in the secondary cancer along the milk duct and glandular cancer in the mammary gland, while there may be metastases in the axillary lymph-nodes with characteristic glandular cancer. In these cases apparently the skin, the milk ducts, and the gland tissues were successively infected, while the new growth in the lymph-nodes represents a true metastasis.

In urging the importance of taking every precaution against cancer infection, notwithstanding the fact that its infectiousness has not been proved, we simply suggest a wise precaution which can do no harm, while it may do an endless amount of good, because in case the disease is due to infection every additional case is a menace to others.

In the meantime it would be equally unwise to ignore the various other theories which have been advanced. According to Virchow's theory, cancer is due to local irritation either mechanical, as in the form of friction or pressure, as in smoker's cancer and the cancer of betel-nut chewers, or chemical, as in paraffin workers, chimney-sweeps, and electric irritation, as in X-ray workers, or heat, as in workers in certain trades.

This theory has an important practical bearing because by avoiding all of these forms of irritation undoubtedly many cases of cancer can be avoided, according to the view of those believing in cancer infection because the soil has not been prepared for the infection.

Colnheim's theory of embryonic origin, Hanseman's of "anaplasia," Ribbert's of "tissue tension," and Adami's of "habit growth," all aid in explaining the development of cancer, but in each instance the seed in the form of some form of infection is missing.

The fact that cancer is a disease of old age can be reasonably explained from the fact of: (1) Reduced resistance; (2) long years of exposure to irritation; (3) long time of exposure to cancer infection.

The fact that cancer occurs upon the exposed portions of the body and not upon the parts covered with clothing would point toward the fact that the exposed portions are not only more exposed to external irritation but also to infection.

In the case of the Kangri burns of Kashmir which cause cancer of the abdominal skin underneath the charcoal warmers worn over the abdomen, we have the constant irritation coupled with the fact that these people are extremely uncleanly, so that no part of their bodies is free from infectious material.

Cancer occurs almost exclusively in portions of the body exposed to the irritation of the outside world. This includes the gastro-intestinal canal which comes in contact constantly with filthy food in locations in which stasis insures long-continued contact and persistent irritation.

We find a notable example in the enormous amount of cancer of the stomach in manure-eating people, *i.e.*, people eating raw vegetables growing in soil fertilized with night-soil or with barnyard manure. A marked example of this is found in the Japanese, who eat such vegetables in abundance and who suffer greatly from cancer of the stomach, while the inhabitants of India, whose religion commands them to boil food and drink, are notably free from stomach cancer.

On the other hand, the Japanese are scrupulously clean regarding their skin, being habitual bathers in hot water. They are very free from external cancer. The people of India, on the other hand, who are not clean as regards their skin, suffer largely from cancer of the skin. The same is borne out among the manure-eating animals. Barnyard fowl are notoriously unclean in their diet and those individuals who do not lose their lives while young are very prone to suffer from cancer. The same is true of the pig, although according to our modern methods, these animals are marketed so young that they rarely reach the cancer age. Is it not possible that the founders of the Jewish law prohibiting the eating of pork may have been founded on knowledge? The same is true of dogs, rats, and mice, who are all subject to cancer, while animals like rabbits and others eating clean food are practically free from cancer.

Marine and Gaylord have shown that fish living in ponds infected with excrement develop cancer, especially of the gills, which are the least protected part of the body constantly in contact with the soiled water, while control animals living in pure water will remain free from this disease.

There are many facts which seem to point to sewage and manure as the home of the organism causing cancer. Behla made a careful study of Luckau and found that cancer was four times as common in the low-lying portions as in the higher regions; in other words, in the portions to which the drainage was carried. He also found much cancer in dogs in this region. He also found that the communities afflicted severely with cancer consumed large quantities of home-grown vegetables. In this part of the country human excrement is used extensively for fertilizing vegetable gardens. Haviland also found after careful analysis that low-lying districts are full of cancer. Mason, in his careful investigation of 400 cases at Leamington, England, came to the conclusion that sewage is an important factor in the production of cancer. An apparent discrepancy comes from the statistics of the city of Edinborough, showing that cancer was found to be more frequent in houses demanding a high rental while tuberculosis was more frequent in houses of low rents. However, it seems clear that the former occupants could afford to eat raw vegetables while the latter had to be satisfied with porridge and less expensive foods.

Again Meldorf states that of 1500 patients in Esquimeaux only 1 per cent. had tumors and that only a few of these were malignant. The low percentage of cancer in the arctic regions has been confirmed by many other observers. In these regions no vegetables are grown which are fertilized with human excrement or with manure, hence there can be no contamination with human excrement. An important exception to this is the city of Hammerfest, but I have not the data concerning its food supply nor its water and sewage systems.

In the tropics observers agree that cancer of the stomach is extremely rare. Here again this form of contamination is absent except where the vegetable gardens are conducted by the Chinese or Japanese. In the tropics human excrement is not used in fertilizing garden vegetables because these grow vigorously without this aid; moreover, fruits are so plentiful that they are used in preference and, of course, these are not easily contaminated.

In studying the statistics I have been impressed with the fact that cancer of the alimentary canal is uncommon wherever food and drinking water are not contaminated with sewage or manure. An interesting observation has been made in the case of the Chinese who drink no unboiled contaminated water but eat an abundance of vegetables fertilized with human excrement. As might be expected, they show a high mortality from stomach cancer.

The most convincing argument, however, of the infectiousness of cancer lies in the studies of Professor Smith, who has proved to the satisfaction of those competent to judge that cancer in plants is due to a microörganism which he has been able to isolate and cultivate and which produces cancer when inoculated upon healthy plants. In human cancer further studies are needed, and it is hoped that these will be continued vigorously and that in the meantime healthy persons be not exposed unnecessarily to cancer infection.

The fact that none of the many observers like Roppin, Schill, Francke, Lampiasi, Scheuerlen, Konbassoff, Doyen, Wickham, Thoma, Sjobring and many others have been able to prove to the satisfaction of others that they had found the microörganism causing cancer must not be construed to prove that such an organism does not exist, because precisely the same failures were experienced before the tubercle bacillus, the bacillus of leprosy, the spirochæte of syphilis, the plasmodium of malaria, and many others were finally discovered.

Clinically all of these diseases were infectious and it was only a matter of patient labor to find the living cause.

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The Treatment of Acute Appendicitis

BY

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TREATMENT OF ACUTE APPENDICITIS.

BY ALBERT J. OCHSNER, M.D.

First, that patients suffering from acute appendicitis without regard to the severity of the infection or its character practically all recover, providing the appendix is removed with proper precautions by a skilled surgeon while the infectious material is still confined to the appendix.

Second, that in almost all cases this condition obtains for at least thirty-six hours after the beginning of the attack.

Third, that in severe acute cases the infection usually extends beyond the tissues of the appendix after forty-eight hours, and practically always if the patient comes under treatment later than seventy-two hours after the beginning of the attack.

Fourth, that the dissemination of the infection originating in a perforated or gangrenous appendix is greatly facilitated by the administration by mouth of food and cathartics.

Fifth, that almost all fatal cases following operation for the relief of acute appendicitis occur in patients who have been ill longer than two days and less than ten days before being operated.

Sixth, that all fatal cases which died without having been operated had received either food or cathartics or both by mouth after the beginning of the attack of appendicitis.

Almost all patients who died following operations had received cathartics or food by mouth after the beginning of their attack.

As a result of these observations I formulated a plan of treatment in 1892 which I have applied constantly since then to the present time. For a period of the first eight years I demonstrated this plan of treatment to surgeons who visited my clinic, treating all cases of acute appendicitis consistently in this way and admitting every case that applied for treatment without regard to the condition of the patient or the length of time that the attack had lasted. A number of my friends introduced the same plan in their clinics, and after having tested its merits and compared the mortality with other forms of treatment, I reported the method before the International Congress in Paris in 1900 and again before the Surgical Section of the American Medical Association in 1901; and many times since the latter date, insisting upon immediate operation in acute appendicitis, usually within forty-eight hours, while the infection is confined to the appendix, and carrying cases with spreading peritonitis by the so-called starvation method with rectal feeding and gastric lavage, described later, to a point at which they can be operated with equal safety.

The method was so radically different from that generally in vogue at that time that it gave rise to very vigorous opposition, but one by one the surgeons with the greatest amount of experience have accepted the principles laid down at that time, so that at the present time I believe the plan has received practically universal acceptance, except among some of the younger men who are not familiar with the history of appendicitis.

In the meantime it has been but natural that surgeons here and there have not taken the trouble to read any of the original papers, and have misconstrued and claimed that the method opposes all operative treatment of acute appendicitis, while as a matter of fact from the first I have insisted upon an early diagnosis and an immediate operation in all cases in which the patient comes under treatment early enough to make it fairly certain that the infection is still confined to the appendix, and have objected only to operations in cases in which the infection had already gone beyond the appendix at the time the patient came under treatment.

The method provides a safe form of treatment also for this class of cases, so that it results in an enormous reduction of mortality in all forms of acute appendicitis.

The plan of treatment and its philosophy can be expressed most clearly in the following concise conclusions:

1. The mortality in appendicitis results from extension of infection from the appendix to the surrounding peritoneum, or from metastatic infection from the same source.

2. The extension may be prevented by removing the appendix while the infectious material is still confined to that organ.

3. The distribution or extension of the infection is accomplished by the peristaltic action of the small intestines.

4. It is also accomplished by operation after the infectious material has extended beyond the appendix and before it has been circumscribed.

5. Peristalsis of the small intestine can be inhibited by prohibiting the use of every form of nourishment and cathartic by mouth and by employing gastric lavage in order to remove any food substances or mucus from the stomach.

6. The patient can be safely nourished during the necessary period of time by means of nutrient enemata. Large enemata should never be given, for they may cause the rupture of an abscess into the peritoneal cavity.

7. In case neither food nor cathartics are given from the beginning of the attack of acute appendicitis, and gastric lavage is employed, the mortality is reduced to an extremely low percentage.

8. In cases which have received some form of food and cathartics during the early portion of the attack, and are consequently suffering from a beginning diffuse peritonitis when they come under treatment, the mortality will be less than two per cent if the peristalsis is inhibited by gastric lavage and the absolute prohibition of all forms of nourishment and cathartics by mouth.

9. In this manner very dangerous cases of acute appendicitis may be changed into relatively harmless ones of chronic appendicitis.

10. In our personal experience no case of acute appendicitis has died in which absolutely no food of any kind and no cathartic were given by mouth from the beginning of the attack.

11. The mortality following operations for chronic appendicitis is exceedingly low.

12. Were peristalsis inhibited in every case of acute appendicitis by the methods described above, absolute prohibition of food and cathartics by mouth and the use of gastric lavage, appendectomy during any period of the attack could be accomplished with much greater ease to the operator and correspondingly greater safety to the patient.

TO REDUCE THE MORTALITY FROM APPENDICITIS.

The following suggestions for the treatment of appendicitis are made with a view of reducing the mortality:

1. Patients suffering from chronic recurrent appendicitis should be operated during the interval.

2. Patients suffering from acute appendicitis should be operated on as soon as the diagnosis is made, provided they come under treatment while the infectious material is still confined to the appendix, if a competent surgeon is available.

3. Aside from insuring a low mortality this will prevent all serious complications.

4. In all cases of acute appendicitis, and in all cases of peritonitis, without regard to the treatment contemplated, the administration of food and cathartics by mouth should be absolutely prohibited and large enemata should never be given.

5. In case of nausea or vomiting, or gaseous distention of the abdomen, gastric lavage should be employed.

6. In cases coming under treatment after the infection has extended beyond the tissues of the appendix, especially in the presence of beginning diffuse peritonitis, conclusions four (4) and five (5) should always be employed until the patient's condition makes operative interference safe.

7. In case no operation is performed neither nourishment nor cathartics should be given by mouth until the patient has been free from pain and otherwise normal for at least four days.

8. During the beginning of this treatment not even water should be given by mouth, the thirst being quenched by rinsing the mouth with cold water and by the use of small enemata and by chewing wax or paraffin. Later small sips of very hot water frequently repeated may be allowed, and still later sips of cold water. There is danger in giving water too freely, and there is great danger in the use of large enemata.

9. All of these cases are greatly benefited by the use of continuous normal salt solution by rectum given by the very slow drop method according to Murphy's directions.

10. All practitioners of medicine and surgery, as well as the general public, should be impressed with the importance of prohibiting the use of cathartics and food by mouth, as well as the use of large enemata, in cases suffering from acute appendicitis or peritonitis.

11. It should be constantly borne in mind that even the slightest amount of liquid food of any kind by mouth may give rise to dangerous peristalsis and may change a harmless circumscribed into a dangerous diffuse peritonitis.

12. The most convenient form of rectal feeding consists in the use of one ounce of any of the various concentrated liquid predigested foods in the market, dissolved in three ounces of warm normal salt solu-

tion, introduced slowly through a soft catheter, inserted into the rectum a distance of two or three inches.

13. This form of treatment cannot supplant the operative treatment of acute appendicitis, but it can and should be used to reduce the mortality by changing the class of cases with spreading peritonitis, in which the mortality is very high, into chronic appendicitis, in which it is very low after operation.

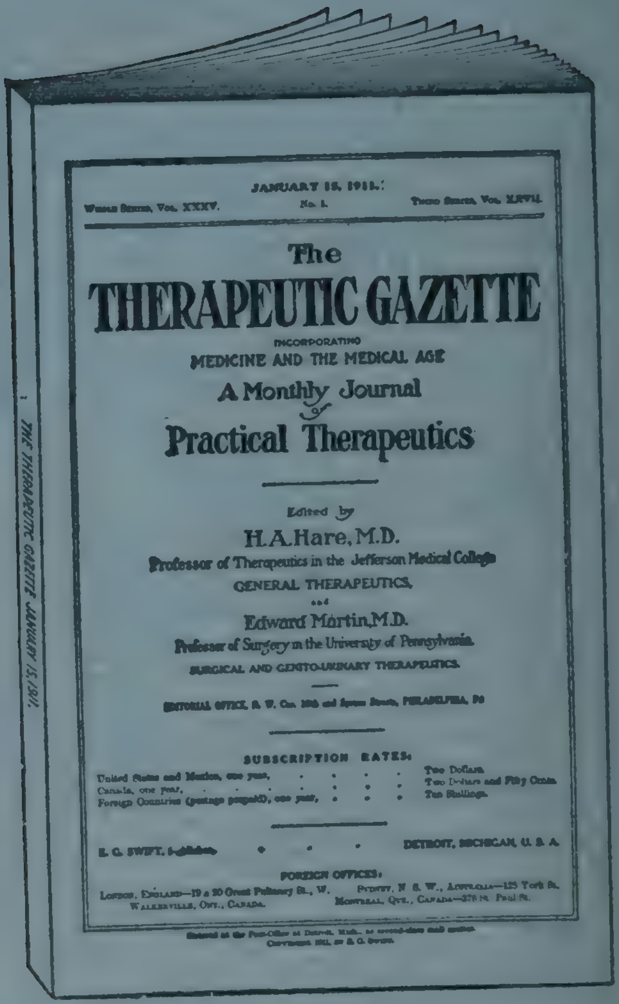
14. It is important to bear in mind the fact that this treatment is always indicated in every case of acute appendicitis without regard to whether an immediate operation is or is not contemplated.

15. It is further important not to be deceived by the very rapid improvement of what appear to be serious cases after introducing this treatment into the belief that the case is not a gangrenous or perforative appendicitis, because such patients may easily be killed by giving food too early.

For a number of years we have placed all of these patients in the Fowler position, and have applied large hot fomentations of saturated solution of boric acid, held in place by an abdominal binder.

Over this dressing we have placed an electric light in the form of a so-called therapeutic lamp. These methods seem to add to the comfort of the patient.

7.



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A Case of Rupture of the Bladder, as Example of Abdominal Injuries**

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The subject assigned to me I will try to present in the form of a case report as illustrative of the general principles involved in abdominal injuries. By this we mean that the title "Abdominal Injuries" is construed to mean injuries to the internal abdominal organs without an open wound, without fractures of the bones, without complications other than the rupture or the injury to the viscera with more or less contusion of soft parts. In other words, that type of case which from the appearance is difficult to make out, and therefore of great importance from the standpoint of diagnosis and treatment. I will first relate to you a case which came under by observation nearly three years ago:

A man about 23 years of age, driver of a truck, was run over at 11 o'clock a. m. on Jan. 9th, 1917. He had a great deal of pain, but not of an excruciating character—severe pain. He was seen by Dr. L. P. Kuhn, chief surgeon of the Lumbermen's Mutual Casualty Co., who rushed him to St. Luke's Hospital, arriving there about noon. The complaint the man made was of desire to urinate and inability to do so. Dr. Kuhn passed a catheter and drew away nothing but some bloody fluid. Pain and distress continued and the Doctor made a diagnosis of rupture of the bladder. At 2:30 o'clock we operated, making suprapubic incision into the abdomen, not trying to make a suprapubic like we do for prostatectomy. We found bloody urine in the cavity and enlarged the opening freely in order thoroughly to cleanse the peritoneum, sponged out the fluid as carefully as possible and found a tear an inch and one-half long in the posterior-superior part of the fundus. This was sutured with two layers of suture and a drain was put in the abdomen. The abdomen presumably was pretty clean at this stage, at the same time there is always a good deal of danger of leaking. While I did not hear all of Dr. Dyas's paper, I presume he said: "When you do not know whether to drain or not, you had better drain." And that is my belief. So in these cases in which you have a ruptured bladder, even though you do not have pus in the urine (which fortunately did not happen in our case), it is better to put in drainage. At the end of five days there was a little leak from these sutures, and the reason for the leak was that the permanent catheter which we inserted into the bladder at the time of operation came out. The catheter always comes out unless you are constantly watching it or unless you have it fastened in some secure way, because there is a continuous force pushing it out and it will come out every time if not fastened in. This was not a retention catheter and we tried to fasten it by adhesive strips. One of the best ways to hold it is to put a safety-pin in the protruding catheter at the end of the penis to which the adhesive tape is fastened. In prostate cases I frequently sew the catheter to the drainage-tube that is put into the bladder, then stitch the drainage tube to the skin, when it cannot come out. The point is that the catheter must be secured in such a way as to remain continuously draining the bladder for at least a week because it takes that long for the bladder to heal. In the peritoneal suture, of course, we try not to get into the mucosa of the bladder, in order that we may not leave any stitches inside there to slough off and become the nidus for a stone. Two layers of sutures were put in this bladder and the abdomen was drained. The wisdom of the drainage was demonstrated in five days when there was some leak which lasted for a few days. It had closed at the end of about ten days.

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*Read at sixteenth annual meeting, Surgical Association of the Rock Island Lines, Chicago, Oct. 4, 5, 1920.

*[Received for publication, Aug. 15, 1921.]

This is a type of abdominal injury coming from external violence. Of course, there are numbers of causes. I am not trying to cover the subject of rupture of the bladder because it is recognized that such rupture comes from various conditions and accidents, as strains and parturition, also in falls on the sacral portion of the spine. In this respect a rupture of the bladder is different from rupture of the intestine. Twenty-five years or more ago rupture of the intestine was considered to be of a hydraulic type; that is to say, it was believed that increase of pressure from force applied to the abdomen was conveyed to the contents of the intestine, causing a rupture.

But later it was demonstrated that nine times out of ten rupture of the intestine was from a crushing injury. A force going over the abdomen presses the intestine against a spine or against some other portion sufficiently hard to tear it, or to tear off the mesentery, or in some other way do violent injury to the intestine. But a full bladder is vulnerable. As you know, the bladder is very deep in the pelvis. You palpate the prostate through the rectum; when you try to reach the prostate you see how far down in the pelvis the base of the bladder is. The protection of the pelvic bones is such that rupture of the bladder, unless it is full, is rather unusual, aside from attendant fractures of the pelvis.

The full bladder, then, is the subject of rupture by hydraulic pressure as distinct from rupture of the intestine, which is nearly always by crushing. So that here we have a rupture of the bladder, in our case at the fundus, probably the least resistant part of the bladder. But rupture takes place in different parts, of course. It is sometimes extraperitoneal, that is, the leak of the urine gets out into the perivesical space or other extraperitoneal tissues and you have an induration there (and I have seen one such case.) coming up like a distinct bladder; and when you put the catheter in the bladder it does not empty much and you get blood. In event it is suprapubic an incision over the pubic bone evacuates pus and urine if the case has gone long enough for pus to form, as in my case. There was a nasty abscess there and a good deal of necrosis from the irritant action of the infected urine in the perivesical space. Then again, we sometimes have rupture of the bladder into the rectum or into other parts, and this is especially true in fractures of the pelvis where rupture is at the base, and it is more difficult to make diagnosis except, that the patient is unable to urinate and you get bloody urine on the catheter.

As to the mortality in rupture of the bladder, twenty to thirty years ago it was very high. In

1892, 136 cases of this type of rupture of the bladder were reported by Bartels, and the mortality in that series was 90 per cent. Of course, that was not long after the inauguration of antiseptic surgery. But the figures all show how long it has taken the profession to act on the conviction and the knowledge that it has, even with the advantages of aseptic and antiseptic surgery. We had at that time antiseptic surgery, later we had aseptic surgery.

In a series of 54 cases reported in 1903 by Dr. D. F. Jones there was 48 per cent mortality. In 1905 a series of 22 cases was reported by Horwitz, which may or may not have included some of these already referred to, with a mortality of 27½ per cent—a mortality still too high. (These just cited are from Keen's "System of Surgery.")

Da Costa in 1919 reports 78 cases collected by Dambrin and Papin (1904) of which 34 died, a mortality of 43 per cent.

Galactionoff (in *Vratch*, Nov. 12, 1910), reported 15 cases operated upon for intraperitoneal rupture of the bladder, with 5 recoveries (three of them were operated during the first 24 hours, one after 36 hours and one after 48 hours). In extraperitoneal rupture without operation there were 11 per cent cures and with operation 30 per cent.

O. J. Fay (*Interstate Medical Journal* for 1919) says that the prognosis in rupture of the bladder depends on timely therapy. The rare instances in which spontaneous recoveries are recorded are to be set down as cases of mistaken diagnosis or as miracles. As the operative therapy has gained ground there has been a corresponding fall in the death rate. Every rupture should be submitted to operation at once. According to Goldenburg the mortality prior to 1895 was 45.5 per cent; in the succeeding ten years (1905) it fell to 20.5 per cent, or less than half of the earlier death rate.

S. Gordon Luker (*Lancet*, Mar. 13, 1920) reports a case of rupture of the bladder associated with a retroverted gravid uterus on a iv-para, age 38, 14 weeks pregnant. Laparotomy was performed, and the linear tear an inch long found on the posterior wall. The tear was sutured and the abdomen closed without drainage. The bladder was healthy. The patient aborted two days later but otherwise made an uneventful recovery.

Blair, George, (*Brit. Med. Jour.*, 1919, 1, 73). Intraperitoneal rupture of bladder uncommon, apt to be overlooked. "To judge from the mortality rate, intraperitoneal rupture of the bladder is a grave injury.

Without operation the rate is given at 98 per cent. Approximately about 50 per cent of cases recover if operated upon. The more prompt the operation the better the prognosis. Attempts at confirming the diagnosis by distending the bladder with boric lotion or gas are of doubtful value and may cause considerable harm by setting up sepsis."

Castagnol, I. R., (*Internat. Clin.*, 1918, 28, 230) does not mention mortality. Ratio male to female—9 to 1.

Goeller, C. J., (*Internat. J. Surg.*, 1918, 31, 867) does not mention mortality. Reports two cases, both doing well. Jeck, H. S., (*Ibid*, 1919, 32, 56) report of one case, patient died.

Kohlmann, W., (*N. Orl. M. & S. J.*, 1919-20, 72, 47). Intraperitoneal rupture of the bladder during puerperium.

Ziegner in monograph says 3 out of 11,000 patients in Berlin, 2 out of 17,000 in St. Bartholomews Hospital, London and 6 out of 9500 in Halle Clinic have rupture of bladder. More often in men than in women; 90 per cent of all reported cases in adult males. Important predisposing cause is drunkenness, account of traumatism. Traumatism, however slight, is generally exciting cause.

The earlier the cases are reported better chances are for recovery. The mortality increases in proportion to the time which passes between the injury and the surgical intervention. Of 16 patients reported by Wiedeman 6 were operated in the first 24 hours; only one died—a mortality of 16 per cent.

Zuckerkandl reports that of 13 cases operated in the first 12 hours 8 recovered and of the 21 operated later only 6 recovered. Improvement in surgical asepsis and technic makes the suggestion possible that at the present time every patient suffering from this accident ought to recover and if there is no cystitis existing, and if the injury is recognized early enough to permit secondary infection from setting in.

E. S. Judd ("Mayo Clinics, 1919"). "Rupture of the bladder is a frequent occurrence, but if this condition is recognized and treated early, all the patients get well. Often this rupture extends into the peritoneal cavity and it is necessary to sponge out the urine. This type of peritonitis, however, is rarely fatal. Operation is indicated in any case of bladder rupture, no matter how late it is recognized.

Dr. Kuhn has reported about 16,000 injuries of all kinds since 1912 up to this time, and that series includes only two cases of rupture of the bladder of the kind I am referring to, withou other injury. He related the second case to me something like this: A school boy who was run over out at Oak Park was taken to a hospital on the West Side, was operated on promptly and recovered. And that is the lesson: If operated on promptly these cases recover. Referring to the old figures, we have seen that the rate of mortality was reduced from 90 per cent to 27½ per cent in about thirteen years. At the present time, if the patient is seen early, the mortality should not be more than 2 or 3 per cent, and perhaps not that.

In connection with the concrete case I have reported, I wish to refer to some other figures given me by Dr. Kuhn: During the past six years he has had 29 abdominal injuries which were serious. Of course, many minor cases were not reported in this series. The company insures a great many lumbermen and they have a large number of injuries called "kick backs," and those have a heavy mortality. Ten of the 29 cases of abdominal injury were operated on, and of those 7 recovered and 3 died. The details are not known to me, therefore I cannot say whether there were any complications. Fifteen cases that were not considered sufficiently dangerous to necessitate operation recovered. Some patients decline operation at first, however much the surgeon may urge it; some of them decline it continually, and some of them decline it until they have gone to the bad and it is too late to operate. However, 70 per cent of the cases operated recovered. Ninety per cent of these had intestinal rupture; one had a liver rupture, and one, I believe, a splenic injury. But in splenic injury we have hemorrhage as the chief cause of death, in liver rupture the same. In the case of liver rupture the condition was not at first recognized, but the patient recovered. Some of these cases were badly lacerated, and at the upper part of the small intestine is where the worst effect is usually noticed, as around the jejunal juncture. In this type of injury, as revealed in the literature on the subject, in the large majority of cases it is the small intestine which is ruptured rather than the large intestine, notably in the series of 19 or 20 cases reported by Dr. Lund several years ago; in all but one of those cases the rupture was in the small intestine, only one being in the colon. Now, that is consistent with what we consider to be the pathology or the etiology or the method of production of these injuries, that is, pressure. The colon for the most part lies in the hollow of the sides, and the transverse portion is the only part that would be very easy to crush against the spine. That is one reason perhaps. Another is much of the colon is in the pelvis and therefore protected as is the bladder.

The one lesson in all these cases is that prompt operation will save a great many lives. Sometimes there is extensive injury to the intestine, the mesentery is torn loose, a great deal of hemorrhage is suffered from very promptly, and the patient is not in condition to save. But if there is any salvation for these cases it is through early operation. Dr. Kuhn has concluded that in any doubtful case of "kick back" it should be hospitalized and explored because his mortality is less with that plan than with any other.

SPINAL ANESTHESIA IN GENERAL AND GENITO-URINARY SURGERY*

George F. Thompson, M. D.,
and
John S. Nagel, M. D.
chicago.

As an introductory remark I would state that my personal experience with spinal analgesia dates back about 10 years, and embraces approximately 1,000 cases. Stovain at first, then novocain, and for the past 8 months apothesine have been employed. Death could be attributed to the anesthetic agent in only one of my cases.

Spinal analgesia is not a new field, but it is one in which much work is still to be done to determine its relative merits and its applicability to certain classes of cases in preference to general or local anesthesia. An American physician, J. L. Corning, was the first to experiment with spinal anesthesia and his findings were published in 1885 in the *New York Medical Journal.* He used 2 per cent. cocain solution and obtained anesthesia in both animals and man. He did no operations and did not even aim to inject the solution into the spinal canal, believing that if he introduced it into the nearby veins it would be carried into the cord, but he must have placed it in the canal, otherwise the effects he noted would not have been so rapid and complete. His work did not stimulate any further researches and was soon forgotten until Quincke's description of lumbar puncture in 1891 led to the rediscovery of spinal analgesia and Bier used it on himself and the procedure was soon established more or less universally. Cocain was used exclusively in the early cases but the mortality was so high that the method dropped into disuse with the exception of certain clinics where efforts to improve the solution, the technic and the selection of cases continued until it was finally again placed on a stable basis.

Following the discarding of cocain, stovain was introduced by Fourneau and Tuffier in 1904 and is still in use. It has a greater paralyzing action on the motor nerves than any other agent and hence provides good muscular relaxation, but is considered more dangerous for this reason if it reaches and affects the respiratory nerves or centers. Novocain has been used but it is not entirely satisfactory, while tropococain is the most popular at present and apothesine has only come into use during the past year or two.

The mechanics and physics of the action of the agent used depend upon certain features of the contents of the spinal canal and upon the curvatures of the bony framework. The cerebrospinal fluid has been supposed to move in and out of the canal, but while the pressure of the fluid certainly changes with position, it is doubtful how much of this is due to actual displacement of the fluid into the cranium from the spinal canal and vice versa.

If a fluid in introduced into the canal, of the same specific gravity as the spinal fluid, it will remain practically at the point of introduction, while a lighter fluid, if the patient is in the vertical position will ascend toward the head and a heavier one sink by gravity toward the lower end of the canal. If the patient is in the horizontal position the normal curves of the spine will influence the motion of the solution toward the head or the feet, depending upon the site of injection and the density of the solution. For example, the lumbar spine has a distinct anterior convexity and a heavy solution introduced at its most prominent point, about the interspace between the 3rd and 4th lumbar vertebrae, may gravitate either upward as far as the most posterior point of the dorsal convexity, approximately the 5th and 6th dorsal vertebrae, or downward into the sacral portion of the canal. If the patient is lying on one side or the other the heavier solution will accumulate along the dependent side as has also been dmonstrated clinically in cases where the right lower limb has been rendered anesthetic while the patient was lying on that side while the left lower retained both sensation and motion. Hence the anesthetic solution will generally remain en masse at that area of the canal it reaches as the result of gravitation and will act upon the nerve tissues in that locality. Some diffusion of the solution along the canal for a considerable distance upward must occur, however, judging from the frequent evidences of its action on the medullary centers even when the head and shoulders are kept considerably elevated. Since gravity so markedly influences the action of the anesthetic agent, solutions both lighter and heavier than the cerebrospinal fluid are used, depending upon the position the patient is to assume for the completion of the operation.

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*Read at the Sixty-ninth Annual Meeting of the Illinois State Medical Society at Peoria May 21, 1919.

The physiologic action of the agent on the functions of the body depends on the drug used and on the strength of the solution. Shortly after injection the analgesia becomes manifest, first in the genitalia, perineum and inner sides of the thighs and then proceeds upward a variable distance and downward to the toes. The interval between the injection and the establishment of a sufficient degree of analgesia to permit of operation varies from 3 minutes to half an hour or longer. Anesthesia is seldom complete, pain sense being abolished, but tactile and muscular senses are often only impaired. Paresis or paralysis is present and the reflexes disappear. The blood pressure is generally markedly lowered and the heart action slowed and weakened while respiration may also be affected and symptoms of syncope or even collapse in certain cases may appear. Pallor, sweating, nausea and vomiting are not infrequent. The low blood pressure is due to paralysis of the vasomotor and intercostal nerves and the lowered heart action to the slow filling up of the heart, the flood being in the dilated internal vessels. The action on respiration is due partly to paralysis of the intercostal nerves, and partly to the lessened blood pressure interfering with the blood supply of the respiratory center. Peristalsis is markedly increased by spinal analgesia and distention of the intestine relieved, thus facilitating operative meneuvers in the abdomen. Death, when it occurs, is probably due to the action of the drug on the efferent vasomotor fibers supplying the splanchnic area which allows of an enormous collection of blood in the large venous trunks so that the patient is practically bled to death by this accumulation of blood in the large veins. Paralysis of the respiratory and bulbar vaso-motor centers may also be fatal. The use of oil and gum arabic as a solvent for the anesthetic agent to allow of slow diffusion has been tried but has not been very successful. Making the solution heavy by the use of glucose so as to prevent too much diffusion has been the most successful expedient.

The solution use by me during the past 8 months has been apothesine in distilled water in the proportion of 1 grain to 1 c.c. approximately a 6⅔ per cent. solution, which when further diluted with an equal amount of cerebrospinal fluid makes a solution of between 3 and 3½ per cent. From 2 to 3 grains of the drug are used, depending upon the patient and the nature and duration of the operation. This solution is considerably heavier than cerebrospinal fluid and gravitates readily in the canal. About 200 operations have been performed, with one death and two serious collapses with recovery. The list of operations performed includes amputations, varicose veins, neoplasms, arthrotomies, plastic operations, bunions, osteomyelites, bone plastics, and aneurysms done on the lower extremities, hernias, varicoceles, hydroceles, amputations of the penis and hypospadias, one of which cases required operating for 2 hours; hemorrhoids, fistulae in ano, plastic operations on the vagina and perineum, dilation and curettage, which are about the most favorable types of cases, as spinal analgesia gives complete relaxation and is free from the muscular spasm and straining so common with general anesthesia and the analgesia is easily obtained with low lumbar injections. Prostatic surgery is a favorable field, as Dr. Nagel will show, both on account of the usually poor physical condition of the subjects and the ease with which anesthesia is successfully induced. In abdominal surgery the perfect relexation of the abdominal muscles and the absence of distention of the bowel make operative procedures easier and less manipulation of viscera necessary and post-operative gas pains are seldom severe or prolonged. Appendectomy, intestinal obstruction, and myomectomy have been successfully done several times, as well as gastro-enterostomy epiplopexy and operations on the bile passages. In intra-abdominal work pain is sometimes caused by traction on the viscera or mestentery and the use of gas for a few minutes has sometimes been necessary. Only one operation on the kidneys—a nephrectomy for tuberculosis, has been done and this was highly successful. The patient was a woman past 50 years of age, who was considered a poor risk for ether. One Caesaraen section was done for eclampsia.

Failure to obtain anesthesia after apparently successful injection occurs occasionally, in 9 per cent. of cases, according to Allen. There may be incomplete or unilateral analgesia, or it may be of too short duration or may be delayed. The causes of the failure may be explained by idosyncrasy, or by errors in technic or possibly by getting an admixture of blood in the spinal fluid.

The indications for the employment of the spinal analgesia may be stated as including all cases in which the lesion is below the diaphragm and in which the use of general anesthesia is contraindicated, such as the aged and debilitated, those with cardiac, vascular and kidney lesions, asthma, emphysema, chronic bronchitis and tuberculosis, diabetes, alcoholics, patients in shock not due to hemorrhage, as for example in crushing injuries of the lower limbs, and strangulated hernias.

Contra-indications are the presence of severe shock and hemorrhage where the blood pressure is already too low and cases where respiration may be too much embarrassed, e. q. marked emphysema, hydro- and pneumothorax, and empyema.

The dangers from the use of spinal analgesia are mainly the results of lowered blood pressure and the consequent effects on the bulbar centers, especially that of respiration. When the dose is injected into the canal it is irretrievable and its action cannot be controlled by withdrawal or by elimination. Lowering the head in order to direct more blood to the brain is not practicable because this allows the solution to gravitate toward the medulla and to further disturb the centers, while sitting the patient up to keep the solution away from the cranium may induce severe or fatal syncope, so that when the dose is too large or idiosyncrasy present a fatal ending is more immediate than with general anesthesia. The only solution is in the determination of the proper dose and the control of its diffusion by correct position before and after injection.

The mortality in my hands has been one in 1000. This case was that of a man past 50 years of age who was septic for several months from a chronic cystitis and pyelitis, and who had an enlarged prostate with 2 vesical calculi, a large inguinal hernia and an immense post operative hernia into which the bladder projected, and a well-marked myocarditis. He was given 3 grains of apothesine in a 4 per cent. solution and very quickly went into collapse and died in 25 minutes, apparently from respiratory paralysis.

Various authors give the mortality as varying from 1 to 200 to 1 to 1,800, which is considerably higher than is usally ascribed to ether. However, there can be no question that there are numerous cases unusited to general anesthesia and in which the fatal outcome is attributed to shock after ether that could be successfully done under spinal analgesia. In comparison with ether the after effects of spinal analgesia are scarcely worth mentioning. Patients who have had both will invariably vote for spinal injection. Headache, nausea, vomiting, vertigo and syncope occur only occasionally and are of short duration. Pain in the legs and back are not frequent nor prolonged. Albumin has been noted at times. Incontinence and retention of urine are rather frequent, especially the latter, and the catheter has to be resorted to quite often and sometimes for several days or even two weeks in one of my cases.

Nervous symptoms and ocular palsies have been described as sequelae, but I have never seen either. Autopsies have not revealed any marked changes in nerve tissue except in experimental cases where lethal doses were employed.

Compared with local anesthesia by infiltration and nerve blocking, spinal anesthesia is undoubtedly more dangerous, but it is much simpler of application, more certain in its effects, incurs less patience and mental effort on the part of both patient and operator, requires a much shorter time and less discomfort on the table, does not obscure the anatomy of the parts and is followed by much less pain and suffering.

Several years ago I began the use of local anesthetics in my genito-urinary work, mainly because a large amount of work of a surgical nature had to be done upon patients who were bad surgical risks. My work was directed more particularly along this line to the removal of the hypertrophied prostate gland. These cases are always poor surgical risks, and under a general anesthetic the mortality rate was high, the patient passing away at the end of the third or fourth day from a hypostatic pneumonia, or a combination of pneumonia and uremia. I used in these cases the prasacral infiltration with results that were highly gratifying, as the mortality rate dropped to a very low percentage, proving conclusively that the general anesthetic had much to do with the previous high death rate, as my technique was the same and the class of patients operated upon did not vary. In age they ran from 63 to 82 years. The anesthetic in all these cases was novocain or apothesine. Several months ago in conjunction with Dr. George F. Thompson we began the use of spinal anesthetic with apothesine. I wish to merely record my experiences in the genito-urinary cases. A total of fourteen patients received spinal anesthesia with one death. Ten of these were prostatics and for carcinomas or carcinoma papillomas of the bladder. In all of the prostatics the final step of the operation under spinal anesthesia was not undertaken until at least one week after a suprapubic cystotomy had been done under local anesthesia, using the infiltration method except in one case. This patient was in very good condition, and a complete operation was done under spinal anesthesia. The one death which is here recorded was an individual who in every sense of the word was a poor surgical risk. The second step was undertaken ten days after the primary cystotomy and he succumbed one-half hour after the operation had been completed. This patient had long been a sufferer from prostatic obstruction, and was very much emaciated and septic.

In all these cases the anesthesia was complete and ideal from the standpoint of the patient and operator. G. G. Smith, in the Year Book of Anesthesia, states that 5 to 10 per cent of spinal anesthesias are not complete, part of which, however, he believes is due to faulty technique. Excepting the death as previously noted, no bad results in the other cases were observed. The pulse rate and respiration did not vary materially. It has been noted that in spinal anesthesia there is always a fall in blood pressure, and the death here recorded, I believe, was due to this cause, the falling being too great a strain for a heart that was already struggling under changes in the heart muscle due to a myocarditis of long standing. In this case I believe the parasacral infiltration would have had a greater percentage of safety for the patient. I believe that spinal anesthesia can be used or rather should be limited to the younger prostatic and individuals of advanced years with other bladder pathology, but whose circulatory apparatus has not undergone marked degenerative changes. The operator who is called upon to do genito-urinary surgery upon patients past the age of fifty-five years will find no one method of anesthesia ideal and suited to all cases. I have quite definitely abandoned general anesthesia in these cases, except possibly in an occasional selected case. In parasacral infiltration and spinal anesthesia I believe I have two methods that will give these patients the greatest degree of safety, using the spinal in the younger division and the parasacral in those cases of marked degenerative changes in the circulatory system.

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ULCER CURE FOLLOWING GASTRIC AND DUODENAL PERFORATION*

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CHICAGO

The results following operation on the stomach and duodenum while showing an increased number of cures, due to a more intelligent selection of technical precedures, leave much to be desired if an accurate account is taken of the clinical symptoms following the various operations performed.

During the past seven years, I have had under observation and have operated on many cases of gastric and duodenal perforation. In this acute surgical crisis I have repaired the perforation as rapidly as possible without further operative procedure, that is, gastro-enterostomy. This rule, however, is not ironclad, for it is necessary in case a previous history of gastric stasis is obtained, and in case the repair is doubtful and constriction occurs, to supplement the closure with a gastro-enterostomy.

It has interested me to know the after history of these cases, and to see if a follow-up might not be of some value in teaching us the type of operation to perform where perforation has not occurred. With this in mind, fifteen patients were studied. My observations included the clinical symptoms if any following operation, the gastric analysis, and the x-ray evidence of any pathology that might exist.

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*Read before the 71st annual meeting of the Illinois State Medical Society at Springfield, May 18, 1921.

Clinical Notes. Thirteen of the patients interrogated stated that they were entirely free from stomach complaint, and felt better than they had for years. A questionnaire relative to their diet elicited the fact that they had not adhered to an ulcer management following operation. The two patients who still complained of gastric distress will be discussed separately. These findings bear out the statement of Deaver, Mayo, Clairmont, and others that spontaneous perforation of gastric and duodenal ulcer is in the great majority of cases followed by a clinical cure.

Gastric analysis did not indicate anything of specific import in the thirteen cases showing a clinical cure. The total and free acidity were well within the normal limit as described by Rehfuss and Hawk. One of the two cases not showing a clinical cure was also negative as to gastric chemism.

The x-ray findings were a surprise to me, for I had expected to be able to demonstrate a definite pathology. This did not prove to be the case, for fourteen of the fifteen cases proved to be negative. No defects could be demonstrated, peristalsis was noted as good, and the emptying time was normal.

The two patients not clinically relieved presented a different symptom complex. V M., aged 50 years, was operated on November 17, 1916, for perforation of the duodenum. A good operative recovery was made, but no directions were given as to post-operative treatment. When first studied, he complained of pain, belching of gas and nausea. He showed the distinct periodicity and chronicity of ulcer. A gastric analysis was negative. The x-ray showed no defect and no six hour residue was present. The patient was placed on ulcer management, and at the present writing shows no return of symptoms.

The second case T. F., was operated on May 29, 1919, for a perforation on the anterior surface of the stomach near the pylorus. Since operation the patient complains of pain coming on about two hours after eating. Nausea and vomiting are also prominent symptoms. States that he vomits more than he eats and that he has lost 30 lbs. in weight. Gastric analysis after Ewald meal shows 240 cc. returned with free acidity of 78, and total acidity of 96. Motor meal shows retention of food products. X-ray examination shows a large 6 hour residue. The stomach is very large, but no alteration of outline is revealed. There appeared to be a notch on the periphery of the first portion of the duodenum, on the lesser curvature, which the roentgenologist took to be an ulcer. At operation on November 13, 1919, I found marked peri-gastric adhesions, producing an almost complete occlusion of the pylorus for a distance of about 1½ inches. No evidence of the former perforation could be demonstrated. A posterior gastro-enterostomy was done, and the patient placed on ulcer management. At the present time, patient has gained 35 lbs. in weight, and is entirely free from gastric distress.

The study of these patients shows that a gastro-enterostomy is not essential to the healing of perforated ulcer, and that the percentage of postoperative gastric symptoms is far lower than after operation for non-perforative ulcer. The work of Wilensky and Crohn, published in the June number of *American Journal of the Medical Sciences*, 1917, should be read by all, especially those who are prone to perform the anastomosis without a serious study of the postoperative results. In their discussion, they state. "It becomes evident that the impression now very generally in existence that gastro-jejunostomy is an operation which in no way impairs the functional efficiency of the stomach is an erroneous one. The operation leaves this organ definitely impaired in a large percentage of the cases. The creation of a new opening in a situation not intended by nature disturbs the peristaltic tons of the stomach, the secretory function, and the nervous mechanism controlling both. In only a minority of the cases does the stomach return to an almost normal state of activity."

From the clinical evidence, made on the fifteen cases studied in this series, and reasoning by analogy, one can accept the observations of Balfour that artificial perforation and excision by cautery presents a very logical procedure in the cure of gastric and duodenal ulcer.

Resection of the ulcer when a cure cannot be obtained under ulcer management has also proved to be of great benefit, but possesses added dangers to artificial perforation with cautery.

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CONTROL OF CHRONIC PAIN[1]

BY FREDERICK DYAS, M.D., F.A.C.S., CHICAGO

CURRENT medical journals are full of accounts of operations designed to restore the lagging functions of youth and are read with avidity by both the medical profession and the laity. Possibly the reaction from the destructive processes of war has stimulated an effort upon the part of the writers to conserve life to the uttermost and to make procreation, even by the senile and by the abnormal, the great aim of the investigator.

While these attempts to stretch the span of life beyond the allotted three score years and ten and to restore the waning power of the sexual glands are worthy of admiration, there are some problems of a nature so practical and so pressing that there is some excuse for directing our energies away from the more alluring search for the fountain of youth. Among these is the urgent need of a method for the accurate and scientific control of chronic pain, especially that due to recurrent inoperable malignancy. The intractible pain of tic douloureux stimulated attempts to give relief to the sufferers by a method less hazardous than the surgical removal of the gasserian ganglion, which had an operative mortality of 50 per cent in the hands of the most experienced operators. To this end avulsion of the ends of the branches of the trifacial nerve, as far as possible beyond their foramina of exit, was practiced with temporary relief. This plan was succeeded by the injection of the nerve trunks by 2 per cent osmic acid. Relief was obtained by this plan for varying periods, but it had the disadvantage of being extremely irritating to the surrounding tissues and frequently caused necrosis when the injection was not accurately made into the nerve sheath.

Injections of alcohol of varying strength have proved satisfactory in a large number of cases of facial neuralgia and have produced analgesia for periods of 6 to 18 months. Thus the efforts to short circuit the painful area in facial neuralgia constitute the first accuracte, scientific, and safe method of combating chronic pain.

It seemed possible, therefore, to render other areas analgesic in which the paths of pain conduction were accessible to the injecting needle. If it is possible to perform almost any type of operation under local anæsthesia why should it not be just as feasible to render any given field painless for a greater length of time?

While the material at hand did not give an opportunity to test out a great many areas, the results achieved in the cases treated at least justifies a more extended application of the principle, i.e., local anæsthesia for the relief of chronic pain.

As the experimental and clinical data have not been sufficient to render an exhaustive report, this paper is presented rather as a preliminary study than as a complete work. The possibilities of mastering pain in hopeless conditions of malignancy was the incentive under which this work was undertaken. Every surgeon has seen cases of malignancy in which apparently none of the older methods gave relief. The woman with recurrent carcinoma of the breast, rocking constantly to and fro with the pain, is a not uncommon patient in any large hospital. The dread picture is familiar to us all, and yet so far no work has been undertaken for its relief. Many persons have no fear of death, yet who does not dread pain?

In many situations chronic pain may be controlled by interrupting the paths of pain conductions by the methods in vogue in local anæsthesia. The scientific accurate control of pain will do much to rob the course of hopeless malignancy of its horrors. The mental anguish may remain, but the somatic suffering in most cases can be spared to the patient. The relief of constant pain revives the drooping spirits of the sufferer and enables him often to put on weight and to gain in strength. The time-honored but inefficient attempts to produce an euthanasia by the administration of ever-increasing doses of opium or other narcotics must give place to a procedure which is efficient and which preserves the individual as himself to the end.

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[1] Read before the Chicago Surgical Society, March 4, 1921.

The short circuiting of the painful area is accomplished by nerve-blocking in the form of neurectomy or of intraneural injection. In relatively small superficial malignant lesions the same end may be accomplished by the healing of the ulcer by radium. This is especially true of lesions about the orifices of the body. Nerve-block relieves the pain during the period of healing.

The agents used for intraneural injection are numerous and it is probable that no single drug is suitable to all cases. Chronic pain due to some condition other than malignancy is perhaps best treated by salt solution, novocaine, apothesin, or quinine and urea, because these produce but temporary loss of pain conduction. In painful states due to malignancy in which loss of motor function is of little moment, alcohol injections of the nerves or neurectomy is indicated. In cases of recurrent mammary carcinoma with great swelling and œdema of the upper extremity, the patient usually has to carry the involved arm, almost as a foreign body. Pain and swelling are so great that movement is practically impossible. Under such circumstances permanent block of the brachial plexus is indicated either by alcohol injection or by nerve resection. Nerve-block of the posterior sensory spinal nerve roots or intercostal nerves is frequently necessary as an adjunct to brachial plexus block because of metastasis in the tissues of the chest.

In thorax operations injection of intercostal nerves is best done at the lateral margin of the erector spinæ muscles near the angle of the ribs rather than close to the spinal column. On account of the many injections necessary when all the intercostal nerves are blocked it is better to mark out the points of attack first and these are later connected by a line of infiltration reaching from the first to the twelfth rib. The patient is in a sitting position with the spine flexed and the shoulder on the affected side carried forward. The nerve-block is now done by introducing the hollow needle just inside the infiltrated area about on a level with the spinous process of the first dorsal vertebra. The point is carried downward until the resistance caused by its contact with the first rib is felt. The under border of the rib is now sought and as soon as the point meets no more bony resistance the needle is forced in for the distance of one-half centimeter further and 5 cubic centimeters of solution injected. The same procedure is carried out in the second rib and so on until the desired area has been blocked off. After 15 minutes there is analgesia of the ribs, muscles, and pleura from the point of injection posteriorly as far forward as the sternum.

Kuhlenkamp's method of blocking the brachial plexus for the relief of acute and chronic pain in the upper extremity is as follows: The first rib is palpated just above the point where it passes beneath the clavicle. Slightly external to this the pulsation of the subclavian artery may be felt. The hollow needle is introduced just beyond this. If blood appears the needle is carefully withdrawn and introduced more laterally. It is carried downward until the resistance of the first rib is felt or until the patient feels the referred pain in the arm. The syringe is then attached and 5 to 10 cubic centimeters of one-half per cent solution apothesine or novocaine injected. Care should be observed not to use the needle as a lever because of the danger of tearing the subclavian vein. Analgesia appears in about 15 minutes.

It is not necessary with the use of novocaine or apothesin to inject the nerve sheath, although this is desirable because these agents are diffusible while with quinine and urea or alcohol it is necessary to inject the nerve sheath. It is therefore recommended that the plexus be exposed by incision under local anæsthesia when permanent analgesia is required for the relief of pain due to malignancy. With the plexus exposed either alcohol injection of the cords or section should be done.

ILLUSTRATION

Case 1. An emaciated almost moribund French woman of about 60 years with a scirrhous carcinoma of the breast. The primary tumor was about the size of an orange and ulceration of the mass was advanced. There were metastases in the axillary and supraclavicular regions, but there had been no swelling of the arm. Pain had not been a marked symptom in this case because of the slow growth of the scirrhous tumor, but there was a continuous ache and discomfort.

A small cutaneous infiltration was made in the usual way just outside the point at which the calcareous subclavian artery was palpable. This spot lay in a deep fossa behind the clavicle which was elevated in the position of forced inspiration by the emphysematous character of the thorax. The needle was introduced at the point where the first rib passes beneath the clavicle. The patient exclaimed when the needle came in contact with the brachial plexus. Referred pain in the upper extremity is the sign that the needle has reached the desired spot. The syringe was then attached to the needle and 10 cubic centimeters of one-half per cent apothesine or novocaine solution introduced, at which time the needle was carried more deeply into the plexus. After the blocking of the brachial plexus the intercostal nerves of the same side from the second to the tenth rib were infiltrated at about the outer border of the erector spinæ muscles and the points of injection were connected with a perpendicular line of infiltration.

Case 2. This woman was operated upon about 1 year previously and now has a recurrence in the scar and axilla with brawny infiltration of the skin and elephantiasis of the arm, the tissues of which closely resembled the bark of a tree in color and consistency. This woman complained of great pain in the chest but comparatively little in the arm. Infiltration of the skin was done with great difficulty on account of the induration and the brachial plexus reached as evidenced by the patient's complaint of referred pain in the arm and hand. Ten centimeters of one-half per cent novocaine solution was injected into the plexus. This was the more difficult because the patient was unable to sit up. The intercostal nerves upon the same side from the first to the ninth were blocked in the usual manner.

CASE 3. Sarcoma of the shaft of the humerus in a man of 40. There was enormous swelling of the arm, the soft tissues being tense and shiny. Ulceration had not occurred. The patient was brought into clinic in a wheel chair, rocking his body to and fro and moaning with pain. The brachial plexus was blocked by the method of Kuhlenkamp and within 10 minutes the patient was free from pain. The following day the radical operation with removal of the shoulder girdle and arm was done under general narcosis and the patient left the hospital as soon as his wound had healed so that further observation was impossible.

CASE 4. Chronic intractible pain of the upper extremity following hemiplegia. This woman complained of inability to sleep and loss of weight and strength because of the constant pain. The brachial plexus was injected by the method described and the patient had a good rest the following night. Forty-eight hours later she reported that there had been no recurrence of the pain.

Case 1 died within 24 hours following the nerve blocking. In this case, however, the fatal termination could not be charged to the novocaine injection as much larger doses have frequently been used without any systemic effect and it is a matter of general experience that 8 to 10 ounces are within the range of safe dosage when used over a large area and in tissues from which the rate of absorption must be slow. Case 2 was free from pain in about 15 minutes after the injection. She had complained of a sense of constriction about the chest before the nerve block but this distressing symptom disappeared, allowing of comfortable respiration. Forty-eight hours later there had been no return of the girdle pain.

From the results obtained in the cases above described the belief is held that much of the suffering endured in the past may be avoided and the afflicted patient, though perhaps in an inoperable condition, may live out his days in peace.

With the pain gone, sleep becomes possible again, the general condition of the patient improves and death finally supervenes as the result of toxæmia rather than from exhaustion due to pain.

No. 12.

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INTRACRANIAL PRESSURE[1]

By CASSIUS C. ROGERS, A.M., M.D., F.A.C.S., Chicago

THE structures within the cranial cavity are normally just sufficient to fill it and nature has provided ways and means to maintain therein a relative constant pressure. Pathological conditions may so interfere with nature that a negative pressure or positive pressure exists. In either instance characteristic symptoms will be manifested. Often a slight negative pressure will produce more distressing symptoms than a relatively higher positive pressure. This is proved by the distressing headaches following the withdrawal of varied quantities of cerebrospinal fluid.

Either a negative or positive pressure may be produced by conditions from within or without the cranial cavity. The loss of cerebrospinal fluid or large quantities of blood are the most frequent cause of negative pressure. Even death has resulted from a too rapid withdrawal of spinal fluid, decreasing intracranial pressure.

It is my purpose to consider positive pressure in this paper.

The cranial cavity is bounded (except in infancy) by a firm non-elastic bony wall incapable of yielding except to great intracranial pressure. It is also surrounded by the second non-elastic structure, the dura, which yields but slowly to intracranial pressure and never rapidly enough to relieve acute conditions.

Positive pressure may be acute or chronic, the symptoms differing greatly with an equal amount of pressure. Of the acute the most frequent cause is perhaps injuries of the head with or without skull fractures. Intracranial lesions without fracture are often more serious than those accompanied by fracture.

A compound comminuted fracture without laceration of the dura produces within itself a decompression rendering extradural pressure impossible at the site of injury but intradural pressure may be but little relieved unless the dura is also severed. Cerebral hernia is always the result of increased intracranial pressure and no attempt should be made to reduce it by external pressure. If, however, the pressure becomes normal the hernia spontaneously disappears.

It must be remembered that intracranial hæmorrhage either extradural or intradural is never sufficient in quantity to kill, but it is the small hæmorrhage that would be considered trivial elsewhere, accompanied by œdema produced by irritation, that causes intracranial pressure sufficient to destroy life.

Acute extradural or subperiosteal pressures from hæmorrhage give symptoms that are pathognomonic and cannot be mistaken if closely observed. If the patient is unconscious, subjective symptoms cannot be obtained but if the pulse, temperature, respiration, and blood pressure are closely and frequently observed they will tell the exact condition of the patient and these alone will invariably tell, if properly interpreted, whether surgical relief is indicated. The acute pressure has a tendency to lower pulse, temperature and respiration, and increase in a direct ratio the blood pressure. The chart illustrates this.

If at the time of injury or hæmorrhage the patient is normal, if after a certain time the pulse is 60, temperature 98, respiration 16,

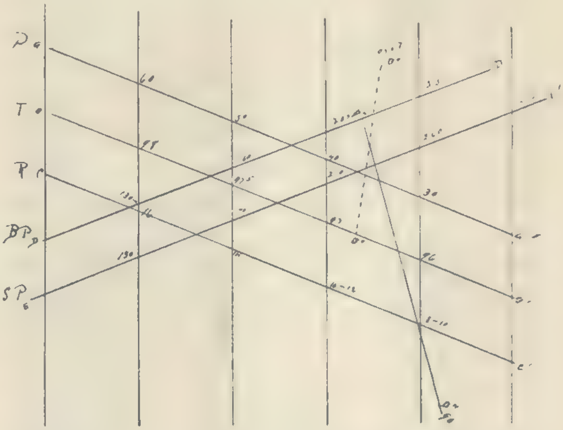

Chart showing acute extradural intracranial pressure· aa′, Pulse; bb′, temperature; cc′, respiration; dd′, blood pressure; ee′, spinal fluid pressure; D″D″, sudden drop in blood pressure; B″B″, sudden rise in temperature, at the same time a fall in blood pressure.

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[1] Read before the Chicago Surgical Society, November 28, 1919

blood pressure 130+, the findings should suggest at once that tihere s intracranial trouble which should demand close observation, preferably by a competent nurse. If the second observation in one or six hours, as the case may be, shows a steady decline—pulse 50, temperature 97, respiration 14, blood pressure 160+, — it is an indication that the pressure is increasing and if not surgically relieved disastrous results may follow.

Third observation—pulse 40, temperature 97, respiration 10–12, blood pressure 200+. A patient cannot live long with such findings. Sooner or later there will be a sudden change in the blood pressure. It drops suddenly to 90−, while the intracranial pressure is found by spinal puncture to remain high, even 200+ or 300+ millimeters of water. Now the time for operative interference has passed and death is the result with or without operation. Spinal fluid pressure remaining high with a sudden diminished blood pressure—(this broken relation) denotes disaster.

Acute extradural abscesses resulting from infections extending from the accessory sinuses, often give an entirely different picture as acute infections have a tendency to increase pulse, temperature, respiration, and often blood pressure. We have here two forces pulling in opposite directions and the result is that often the patient who has had an acute sinus infection with a rise in pulse, temperature, and respiration will suddenly have a normal pulse, temperature, and respiration, but apparently otherwise is much sicker than before. The sudden drop in pulse, temperature, and respiration apparently has been a common deceiver to some of our specialists in otology and has caused them to delay operative procedure, and brain abscesses and death has been the result. Experience has led me to believe that all cases of extradural and brain abscesses that are the result of sinusitis extension belong to the experienced general surgeon. As soon as a patient with acute sinusitis has an increase of pain associated with nausea and vomiting and slow cerebration, there is invariably an extension to the dura irrespective of the pulse, temperature, and respiration and radical surgical interference is demanded. If the infection has extended beyond the dura, localized or diffuse meningitis with the classic symptoms is present and lumbar drainage only tends to increase the area of infection.

In all extradural pressures, lumbar drainage for the relief of intracranial pressure is contra-indicated as only harm can be obtained. Lumbar puncture for diagnostic purposes is always permissible and advisable if done by those competent. If the infection is extradural the examination of the fluid may be negative.

Intradural pressure may be, subdural, subarachnoidal, intracerebral, and intraventricular. To relieve the pressure the dura must be opened, except in the presence of subarachnoid pressure, which may be relieved by lumbar spinal drainage.

The symptoms differ greatly as to location. Subarachnoid hæmorrhage may be associated with weak rapid pulse, slow irregular respiration with elevated, normal or subnormal temperature. Lumbar puncture reveals blood in the spinal fluid and while the patient is unconscious there are at times involuntary movements of groups of voluntary muscles, such as the moving of an arm or leg. The patients are restless and cry out at intervals. For this reason, the site of the lesion is sometimes looked for on the wrong side as the quiet side is taken for the paralyzed side while the irritation to the motor cortex by the blood produces contraction of the opposite arm or leg and the lesion appears to be located on the same side as the apparent paralysis which is never the case.

Acute intracerebral lesions located in silent areas produce symptoms very similar to the extradural lesions and cannot be relieved by lumbar drainage.

Acute intraventricular lesions or internal hydrocephalus cannot be relieved by lumbar drainage for either the foramen or Monro or Ilir or both are closed and the ventricles cannot be drained by drawing fluid from the subarachnoid space. Observations of the pupils and ophthalmoscopic examinations tell us little or nothing in acute cases but are always recommended.

There is one class of chronic intracranial pressure, however, that can be satisfactorily treated by lumbar drainage. I have been unable to find mention of such cases in medical literature. If similar cases have been reported I would be glad to be informed where the reports can be found.

Recently I have been observing a series of cases that have in most respects a normal mentality. Some resort to petty thievery, others do many things that are contrary to a normal social standing, while others commit grave offenses. They apparently have a conscience but cannot control it. Attempts to discipline them have no lasting results. They may be punished and will immediately commit the same offense for which they were punished. They are bright and active, apt at learning and apparently are normal. Physical and roentgen examinations reveal nothing abnormal, questions are answered intelligently and correctly, until they think it is to their advantage to lie and then it is almost impossible to obtain the facts.

The pulse, temperature, respiration, and blood pressure are normal, there are none of the usual symptoms of intracranial pressure, no headache and no visual disturbances, but the spinal punctures reveal the cerebrospinal fluid under great pressure—from 200 to 300+ millimeters of water registered by the spinal fluid manometer. This may be our only clue that there is cerebral inefficiency. The rapidity of the flow of cerebral fluid from the needle gives absolutely no information as to the intracranial pressure. The pressure is easily reduced by lumbar drainage and remains low for days and perhaps permanently if proper treatment is administered. All laboratory findings are negative except the serological cerebral localization test of Abderhalden as done by Dr. Retinger at the Durand Hospital which invariably reveals in these cases a 2+ and often 3+ reaction of two or more of the glands of internal secretion: the pineal gland, pituitary (posterior), corporus mammilaris (anterior), 2+ or 3+ of the ovaries or testicles, suprarenals, thyroid, and frequently thymus.

The administration of the defective internal secretions will usually prevent the return of the increased intracranial pressure when it is once relieved by lumbar drainage.

As long as a normal intracranial pressure is maintained, by balancing internal secretions by supplying artificially the defective secretion, these patients remain good law-abiding citizens.

It is my opinion that many of our juvenile offenders belong to this class of cases and that our courts should sentence them to laboratories for examination instead of our present day reformatories or schools of crime.

Dr. B. O. Orndoff has furnished me with the following report on the examination of Miss B., one of a series of similar cases.

> The examination consisted of roentgen observations of the head, thorax and abdomen, analysis of the blood, spinal fluid and urine together with a consideration of the history and physical findings.
>
> The findings, which seem to have a bearing of importance in her case, are in the head, a rather small pituitary fossa and some apparent disproportion of major anatomical structures which are probably developmental and not pathological. The chest is negative; the abdomen negative with the exception of some evidence of fixation of the cæcum and appendix, and the presence of a slightly enlarged ovary on the right side. Findings in the gastrointestinal tract are negative other than those mentioned. The blood was found under normal pressure and gave a negative Wassermann reaction and no cytological proportions. The spinal fluid registered a pressure of 240 millimeters and decreased as low as 100 millimeters after the removal of 30 centimeters of fluid. The cell count of the fluid was negative as well as the Wassermann and Lange reaction. The physical findings were practically negative.

Dr. Retinger's serological report of Miss B.

The following are the results of the tests on the glands with the blood of Miss B.:

Liver	negative	Ovary	++
Adrenal	+++	Thymus	+
Thyroid	±	Spleen	+
Parathyroid	−	Lung	+
Kidney	−	Pineal gland	±
Pituitary (anterior)	−	Pancreas	−
Pituitary (posterior)	++	Placenta	−

It seems that if there is no brain trouble, there must be disturbance in the secretion of the adrenal and the ovaries. They are known to be in a close relation.

Candate nucleus	−	Ant. perforated space	−
Thalamus		Corp. mammillare	+++
Anterior nucleus	−	Geniculate Lat	+
Median nucleus	± (+)	Superior Coll	−
Lateral nucleus	−	Inferior Coll	± (−)
Putamen nucleus	± (−)	Pineal	−
Optic chiasm	−	Pituitary (anterior)	−
Olfactory	−	Pituitary (posterior)	++
Dura	−	Pons	−
Fornix	−	Medulla	−
M. amygdala	−	Cerebellum	− all
Globus pallidus	−		negative.

SHORT CIRCUIT OF THE VAS DEFERENS

By CHARLES MORGAN McKENNA, M.D.
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SHORT CIRCUIT OF THE VAS DEFERENS

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By short circuit of the vas I mean joining together the patent lumen of the vas with a section of the epididymis or testicle. Just a word regarding the anatomy of these parts in order to make the following clear.

The testis is composed of an enormous number of much convoluted seminiferous tubules, which fill up the intervals between the septums. These tubules form larger tubules, and finally make up the vasa efferentia, and on reaching the head of the epididymis form a larger tube which is called the canal of the epididymis. After a tortuous course, this ends at the globus minor and opens into the vas deferens. This is at the extreme lower pole of the testicle. The vas deferens begins at the tail of the epididymis and ends in the common ejaculatory duct, where it enters the prostatic or first part of the urethra.

The operation under discussion is usually done to repair an old gonorrheal epididymis in which there is an obstruction of the vas between the tail of the epididymis and the external inguinal ring. It is of the greatest importance, therefore, to know whether that part of the vas is patent between the external inguinal ring and the opening of the ejaculatory duct into the prostatic urethra. This may be investigated at the time of the operation, but better should be done two or three days before the operation by drawing the vas through a small skin opening and injecting it with a solution of argyrol or collargol. By injecting the vas with either one of these solutions, the urine will become discolored a dark brown on first urination, hence, showing the vas between the incision and the prostatic urethra to be patent. If it should be found that the vas was not patent, it would be of no avail to do a short circuit operation, but Lespinasse's operation of the distal end of the vas becomes the one of choice.

Granting that the lumen is patent, the next point to be considered is the condition of the channel as to infection. It would be quite an error to go on with the operation if the seminal vesicle or ejaculatory duct contained any pathogenic organisms. I therefore wish to emphasize that it is quite important that the operator be absolutely sure that these parts are perfectly clean and will perform their duty if called on, provided one succeeds in opening the passage for the spermatozoa. If there is any doubt as to this condition existing in the seminal vesicle or ducts, these should be treated after Belfield's method.

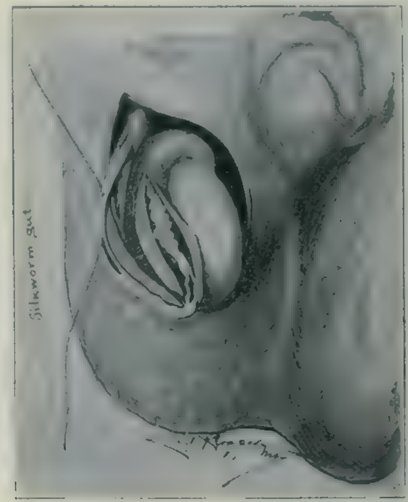

Fig. 1. - Exposure of vas deferens; silk worm gut in lumen of cord.

Dr. E. D. Martin of Philadelphia in 1900 tried this operation with success. He used four fine silver wires for the anastomosis and used the head of the epididymis as the base for the implantation. This was done on each side at different sittings, and at the second operation succeeded in getting free spermatozoa in the urethra.

Scatudo in 1901 tried the same operation by doing an implantation of the vas into the rete of the testis. In his case, he did a complete resection of the epididymis, using the argument that if it were tuberculous, he could still get free sperm direct from the testis. One of his dogs escaped without an examination being made, and the others did not show any live sperm.

Boarri in 1908 reported a case in which he succeeded in getting the sperm through direct from the rete in the testis.

My own work has been done mostly on dogs at the St. Joseph's Hospital. This is more or less of a preliminary report on the work thus far carried out. In the first three dogs operated on, the incision was made over the vas in close proximity to the epididymis. The vas was divided at this point and brought in apposition to a section of the epididymis, the incision in the epididymis being made in the head. In the first three cases, ordinary catgut was used to make the anastomosis, and as a result no sperm could be found in the urethra. In the next three cases, two were done the same as the first, and in the third a fine silver wire was used instead of the catgut, which was removed later. In the case in which the wire was

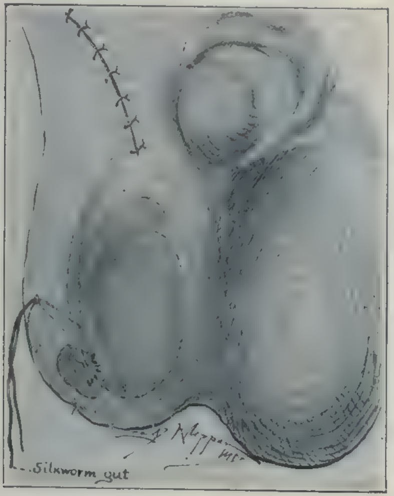

Fig. 2.—Anastomosis of vas with epididymis.

used, no trouble was manifested in finding free spermatozoa in the urethra. Before doing the next two, I consulted Dr. Belfield, who explained that, while he had never tried it or seen anything in literature, he thought it would be a good scheme to introduce a silkworm-gut in the lumen of the vas, and draw it out through the skin. This was done, and I shall show later in the technic of the operation how it materialized. In the last two dogs operated on, a side anastomosis was done instead of the end of the vas being used as at first. The silkworm-catgut introduced in the lumen of the vas was not used as an anastomosing suture, but as a means to leave the lumen patent and remove any blood clot that might tend to obstruct the vas after the operation. This plan worked perfectly in all cases, even in one case in which the vas was crossed over to the opposite epididymis.

The work on man so far consists of six cases, five of which can be reported. Out of these five, two have passed living sperm, three have not passed any, and in the last one, sufficient time has not elapsed between the operation and the time of the writing of this paper. I feel that I am somewhat to blame for the nonappearance of the sperm in these cases. While there had been success with the operations performed on the lower animals, it is quite a different thing to operate on man when pathologic conditions exist. The error was made in doing the anastomosis, the head of the epididymis, instead of the tail, being always used. The selection of the portion of the organ to be used depends altogether with the operator. This may or may not be in the extreme tail of the body.[1]

It is not a good plan to do the anastomosis unless plenty of free motile spermatozoa can be found. Free spermatozoa cannot be mistaken by the naked eye when there are enough present. The appearance of sperm in the vas is that of white milky pus passing through blood. After a few observations there will be no difficulty in locating the best field for the implantation. But considerable time should be spent in locating a suitable section for the implantation, to assure the patient a fair prognosis. Thus far, I have had no difficulty in finding the motile sperm in the tail of the epididymis or one-fourth inch above the tail. In one of the cases in man in which operation was performed, the amount of sperm was so much that I was sure there must have been some pus still remaining in that section of the epididymis. Before the operation was completed, a slide was covered with the fluid and sent to the laboratory for diagnosis. Dr. George Dick made a microscopic report which showed the slide to be completely covered with living sperm. In this case sperm was found afterward in the urethra.

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[1] In one of the first cases reported in which the head of the epididymis was used for the implantation, the second and fifth nights after the operation the patient had an emission in which blood and argyrol were found in the discharge. This was certainly a proof that the operation was a success, and if free spermatozoa had been present they would have passed through.

TECHNIC

I base my technic for short circuit or transplantation of the vas deferens on the contention that vas operations should follow out sound surgical principles as used in surgery in other parts of anatomy. Some of the important points are:

1. Clean exposure and fixation of the cord.
2. The patency of the vas between the incision and the ejaculatory ducts. (This information is obtained by doing an injection of the vas previous to the present operation, Belfield's method.)

This operation is indicated when the occlusion is below the internal inguinal ring. The procedure is as follows:

The patient is cleaned and prepared as for any other surgical interference, except that tincture of iodin is not allowed to touch the scrotum in order to prevent excoriation. The patient is put under general anesthesia and placed in a slight Trendelenburg position. An incision is made in the same location as in operating for inguinal hernia and carried to the pendulous portion of the scrotum. The vas and epididymis are exposed at this point. A tenaculum or volsellum forceps are placed about the cord at its junction with the epididymis. A silkworm-gut is carried underneath the vas about 3 or 4 inches above the forceps. This is done to fix the cord in order that a clean field may be maintained, and makes the entrance to the vas easier for the operator.

The vas deferens is stripped of its covering for 2 or 3 inches above the epididymis by gauze dissection and Kocher director. Great emphasis is laid on this point as it expedites the operation and prevents any error in getting in its longitudinal axis in the lumen of the vas. An incision is made into the vas about one-half inch long. A fine pointed bistoury is the best instrument for this purpose. The incision is made about 2½ inches above the head of the epididymis. A piece of silkworm-gut is introduced into the lumen of the tube by means of a long hypodermic needle. The thread is put into the proximal end of the needle and pushed in just to the distal margin. The needle is now placed in the incision already made in the vas and pushed into the lumen of the cord above to the incision, and the point of the needle is brought out through the wall about 2 inches above the lower opening. The thread is drawn through the needle at this point, and the needle withdrawn through the lumen of the vas, thus leaving the silkworm-gut extending from the incision below and out through the wall 2 inches above, both ends of the thread being free. I wish to mention here that this is Dr. William Belfield's suggestion, and to him I wish to give all credit. Two sutures of chromicized catgut are placed through the incision already made in the vas and brought down into the opening made in the epididymis. The sutures are tied for permanent fixation, thus making the anastomosis of the vas with the epididymis and out through the skin, the sutures being tied loosely on the outside. These stitches are left in for from ten to fourteen days in order that the lumen of the vas may remain open. The tunica is closed in the regular way, as are the rest of the anatomic structures. The wound is healed and the scrotum put in a well-elevated position. The patient remains in bed from seven to ten days, at which time the skin sutures are removed.

The scrotum is carried in a suspensory from four to five weeks after the operation in order that no pressure be brought to bear on the anastomosed vas. Intercourse should not be allowed until six weeks after the operation.

CONCLUSION

I wish to emphasize the following points:

The vas should be free from infection.

The section of the epididymis used should contain plenty of free sperm, and the tail used for implantation.

108 North State Street.

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SOME PRACTICAL PHASES OF LOCAL ANESTHESIA.*

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In the use of local anesthesia we have not yet reached that ideal of perfection to which all honest effort hopes to attain. However, in the hands of a thoughtful and careful operator it gives such satisfaction that we are stimulated to further endeavor.

Results are what count and ideal results should be our only goal. If I am able to say something that will renew your interest and assist you in obtaining better results or to approach that ideal of perfection in local anesthetic application, that will be my reward.

The various therapeutic preparations, their chemistry and action, and the principles underlying the use of local anesthesia are too well known or readily found in current literature to warrant any repetition at this time. However, I feel that we owe it to ourselves to pause occasionally and spend a few moments in considering the more practical side of this subject and review a few of the points that may enable us to apply those agents with more accuracy and satisfaction.

I have been assured by chemists and other scientists that certain chemical compounds exist which will produce anesthesia when used under proper conditions and further they have assured me that these same compounds are relatively free from any deleterious action. In these men and their formulæ I have placed my confidence and I am frank to state that I have not been betrayed.

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*Read before the 70th annual meeting of the Illinois State Medical Society at Rockford, May 19, 1920.

Those of us whose duty it is to apply these same formulæ have not the time nor facilities for proving the claims made by their originators, except by clinical application. Surely one needs but little clinical experience to be convinced that their claims are just and right. These preparations are now easily available. There exists at present almost an ideal relationship between the producers of these preparations and the clinician. Practice has so well proven their claims that little discretion need be used in the choice of one of our standard anesthetic preparations. As new Preparations are offered to us great care and close application must be insisted upon before they are received into the family of local anesthetics.

If the same scientific cooperation could exist between the producers of all therapeutic agents and the clinicians as there now exists between the producers of anesthetic formulæ and the clinician, the millenium would be at hand. Unfortunately the action of most therapeutic agents is not as accurate as the local anesthetics and then strictly scientific advance is not in keeping with commercial activity thus the source of error is difficult to eradicate.

The Operator. There are certain phases of the life of the surgeon that must be developed or educated before he can hope to use successfully any local anesthetic agent. First he must learn to approach his patient in such a way as to stimulate confidence and thus enable him to secure the proper amount of cooperation. Until such a time as the fear of pain can be controlled by confidence or some other force your patient will not be in sympathy with your efforts.

Secondly, the surgeon must realize at once that he is his own anesthetist and the proper amount of time and effort to put the part to sleep must be consumed before the patient is ready for operation. The present day surgeon has been trained to approach his victim with scalpel in hand and at once makes the incision, while in local anesthetic work he must approach his victim with the hypodermic and sufficient scientic consideration to carry him through a period of ten to twenty minutes or even longer, during which time he will carefully inject the anesthetic and wait patiently for it to take effect. When sufficient time and anesthetic have been consumed the part is ready for operation, just as it is when the ether has been dropped gently and slowly until narcosis is produced. When the surgeon has carefully carried himself and his patient through this stage he is ready for the operation and should proceed just the same as though the patient were in deep anesthesia.

At this time the patient should be instructed that he will feel a tugging sensation as though some one was pulling at his clothing, but he should not complain unless real pain is experienced. When the pulling or tugging sensation is experienced the patient is well convinced that the next second will bring pain and he will often complain when he will admit at the same time that he did not experience real pain.

The psychic side of local anesthesia. Most patients are apprehensive. There are but few with implicit confidence in the efficacy of your flaunted remedy to take away or ward off the pain. Many are stimulated to a high state of excitement by the mere thought of an operation. To be cut is to suffer pain in the minds of all. The elements of fear, pessimism and mental alertness must be well under the operators' control if he wishes to be successful, and the pessimism is the one great factor that must be removed.

Children are more easily influenced from the psychic side than the adult. They are not aware of what operative procedures really mean; they do not think as well for themselves and they are far more open to suggestion.

Allen has made a careful study of this phase of local anesthesia and gives the following resume:

> With the attention fixed on the idea that pain is to be inflicted and all the senses keenly alive and active, awaiting the impression, the least touch or manipulation may excite the idea of pain and cause the patient to cry out.
>
> Pain may be to many an incident of little concern; they are either anesthetic or stoical, feeling very little or are able to control their expression of pain. Others are hypersensitive or hyperesthetic, either being extremely susceptible or they possess little or no control over their feelings. These differences are largely individual, although there exists certain factors as race, age, social and educational status of the individual which influence the susceptibility. It is likely true that the dark skinned races, the Slavs and Teutons are less susceptible to pain than other races as the Latin and Semitic stock. Old age generally is less susceptible than youth or adolescence, due to the more sluggish condition of the nervous system, while infancy, due to psychic influence and poor sense of

locality, may bear certain pain well, but is easily shocked by severe trauma.

The social condition, refinement and educational status and occupation have much to do with the susceptibility to painful impressions as we would naturally suppose. Thus a highly refined individual following an intellectual pursuit would be expected from his mode of life, breeding and occupation to have a more highly developed and sensitive nervous system than the laborer or farm hand, accustomed to exposure to the knocks and buffs of hard life. Sensitiveness to pain varies with individuals; a person with a strong will may suffer great pain without flinching, while a mere trifle may cause great complaint from another. Those thin of build and neurotic temperament with exaggerated reflexes, as lively knee jerks, suffer more than hardy and stout individuals. The very ticklish and those who are easily startled and highly nervous, bear pain badly, while those not so responsive make less complaint. This establishes an association between reflex activity and sensitiveness to pain.

Advantages of local anesthesia.

1. Local anesthesia has been a great blessing to the operator as well as to the patient, and in many cases its superiority over general anesthesia is so great that the element of comparison does not enter the discussion.
2. It removes at once all the dangers and disadvantages of a general anesthetic and these alone are sufficient to prompt the careful operators to favor local.
3. Does away with surgical shock.
4. Shortens the time of preparation and thus the operation. The patient may be operated upon in the office or immediately after entering the hospital regardless of full meal or other coexisting conditions.
5. It obviates the necessity of calling another

man to give a general anesthetic especially in all minor work.

6. Does away with the necessity of a twenty-four to forty-eight hour stay in the hospital, which is essential following the use of a general anesthetic.
7. Induces many patients to submit to surgical procedures by removing that fear of a general anesthesia.
8. It can be used successfully in some cases where a general is contraindicated.
9. As shown by Geo. W. Crile, local anesthesia blocks the nerve impulse and thus prevents nerve exhaustion, while an ether anesthesia acts like a veneer during an operation and does not prevent traumatic nerve impulses.
10. The operator's peace of mind and clearness of conscience in these cases fully repays one for the extra effort often necessary to obtain good results.

Disadvantages of local anesthesia.

1. That local anesthesia has its disadvantages must be admitted and its use should be determined only by the weight of evidence in favor of or against it in any given case.
2. That it cannot be used in some cases is certain.
3. In other instances the cooperation of the patient as obtained by a general anesthesia is impossible with local.
4. That it may in rare instances interfere with healing of the wound cannot be disproven.
5. That it may increase the dangers of infection is a point well taken.

6. The hypnotics used in conjunction with local anesthesia are not entirely free from danger.

Indications. It was the custom a few years ago to teach that the only indications for local anesthesia were the contraindications for a general anesthesia, but today local anesthesia is certainly indicated in any operation where it can be used with satisfactory results, and when it does not delay the patient's recovery. This has come to include all minor surgery and has so invaded the field of major surgery that the general anesthetic is rapidly approaching the discard.

Contraindications. General anesthesia will always find an important place in surgery and in the hands of the skilled anesthetist its dangers will be lowered to a minimum, and with such skill at the command of the operator many of the major surgical procedures can be carried out more safely and more satisfactorily when general narcosis is obtained.

We are thus safe in saying that local anesthesia is contraindicated when—

1. Local narcosis cannot be produced.
2. When better results are offered by general narcosis.

Preparation of the patient. In a great many instances no preparation is needed except that of the field of operation. Most patients who are to undergo a minor surgical procedure can very quickly be persuaded that everything can be taken care of without discomfort to themselves, but when a major or extensive operation confronts the patient it is far more difficult to overcome that element of fear and to allay that pessimistic attitude.

For the average patient it is well that he should enter the hospital the preceding evening and receive the proper preoperative treatment and have the field of operation prepared according to recognized surgical principles. During the few hours just preceding the operation the mental excitement is prone to reach a high tension and in most patients this becomes so evident that unless something is done to counteract it the patient is in an unfavorable state of mind for the use of a local anesthetic.

It is my opinion that in most cases the operator as well as the patient will be able to carry out his part more effectively if this mental unrest is in part overcome by a preliminary hypnotic. In this part of the work I have not followed any fixed rule but have tried to treat each case with due consideration. With the extremely pessimistic and over anxious, more hypnotic is required, while in the more reserved and reconciled, a moderate amount or none, as the operator decides. Morphin, gr. 1-6, and Scapolomine, gr. 1-100, hypodermically about a half to one hour before operation is all that is needed; in other cases a quarter and a fiftieth are required. Chloretone gr. X or XX an hour and a half preceding operation with gr. X three quarters of an hour before, will work well in some cases. While I have not given it a trial, I have every reason to believe that moderate doses of bromides an hour or more preceding would work well in other cases.

When the patient is thus prepared he arrives at the operating table in a condition where he can answer all questions intelligently and is perfectly conscious, but his mental activities are benumbed, to the extent, that he has lost interest in his surroundings and he is not disturbed by the ghostly appearance of the operator and his associates. When the anesthetic needle punctures his skin he realizes that something has happened, but the sensation of pain is so far overcome that he forgets it almost instantly and rarely makes any subsequent complaint.

Anesthetic preparations. The literature abounds with the merits and demerits of a large number of local anesthetic preparations. Most of these have reached the discard long ago, but there are a few preparations that are definite in their action and have withstood the attacks of scientific onslaught so well that they have rightfully attained an enviable position in our armamentarium. Cocain, one of the oldest and most respected, has such a definite and efficient action that it needs no discussion, but carries with it that reputation of being so treacherous that its use is almost limited to the anesthetizing of mucous and serous membranes.

Novocain, a more recent addition to our list, has gained the favor of numerous operators and has proved itself to be efficient and almost harmless, and since the German patents have been cancelled and American manufacturers permitted to produce it, it is very easily obtained.

Apothesine, about the last to be added to our list, has received very wide endorsement and has been used during the past two or three years probably more extensively than any other local anesthetic preparations. During the recent war novocain was not available for a long time and I soon found apothesine a very serviceable remedy and have used it almost exclusively for more than three years.

It has been found that all these three preparations are efficient in solutions of from a quarter to 1 per cent. Cocaine, being the more toxic, is used in the weaker strength. Novocain and apothesine in solutions of ½ to 1 per cent can be used with the best of success and used in large quantities because of their low toxicity. Of all known local anesthetic remedies apothesine is probably the least toxic. I have used it repeatedly in major operations, three, four and even five ounces of a ½ to 1 per cent solution, and have never witnessed any toxic effects. When injected subcutaneously or beneath the mucous membrane, it fills all the requirements of any local anesthetic, and is for all practical purposes free from any deleterious effects.

Technique. For a detailed technique for the use of local anesthesia I should like to refer you to Braun, who gives very minute instructions for the various operative procedures. However, I want to impress upon your minds that the principal underlying the use of local anesthesia is based upon Crile's proof of the efficiency of cosain, when injected into a nerve trunk, to produce the so-called "Block" so that neither afferent nor efferent impulses would pass.

When any operation is to be done under local anesthesia, whatever the method or location of the injection of the solution, either the large nerve trunks or the smaller branches are effected and thus "blocked."

It is my impression that in most operative procedures it is not practical nor entirely safe to seek for and inject the main nerve trunks nor even the larger branches, when results can be obtained by moderately extensive subcutaneous injections.

Intradermal applications of a local anesthetic are useless, ineffective and even dangerous if made along the line of incision. It is also true that in most instances deep seated injections are not necessary when the solution is introduced some distance proximal to the operative field. The free use of subcutaneous injections on the proximal side will in most cases anesthetize both superficially and deeply. In laparotomies and in bone work deep injections may be indicated. In abdominal work, when the peritoneum is reached, the use of an angular needle to inject between the peritoneum and the overlying muscle will produce complete anesthesia of all the deeper layers.

Results. Primary union of all wounds other than septic is to be expected. I have yet to see any disturbance in the healing of the wound that I could attribute to the anesthetic; healing takes place as in cases of general anesthesia. All nerve tissue which is reached by the anesthetic has its functions temporarily suspended and this lasts for a period of from one and one-half to three hours. There has never been any excessive scar, keloid or painful scar, nor any evidence of subsequent derangement of nerve function.

Conclusions. As I stated in the beginning of this paper, "Ideal results should be our only goal." With my present experience I am free to say that from an anesthetic standpoint I am in close proximity to an "Ideal." I have but one failure to record in the last forty cases and that I appreciated then, as I do now, was a very unfavorable one. R. E. Farr in the *Journal A. M. A.*, December, 1919, records 551 cases with less than 2 per cent. of failures.

The element of time plays a most important part in local anesthesia. After injecting your solution, time must be allowed for it to act, and this varies in different cases and conditions from a few minutes to fifteen or twenty. We are all inclined to impatience, and this alone will lead to failure many times.

The psychic element is extremely important, and unless you can control it you are doomed to failure. Children are more easily influenced than adults.

Those of you who are skeptical should be open to conviction and begin now to re-educate that side of your make-up and thus give your patients the advantages of local anesthesia wherever possible and take away that element of danger that goes with ether and chloroform.

That local anesthetics are a success is undeniable, and this success is yours with but little effort.

We owe it to our patients and ourselves to make more extensive use of these preparations and thereby contribute more to the art of surgery and the science of medicine.

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DISCUSSION

(Abstract)

Dr. Sloan (Bloomington) thought this subject very important and complimented the doctor on one of the best practical papers.

He finds radical operation to remove a gland in the neck is easier to perform with local anasthesia, because the muscles and layers of fascia are differentiated by the anesthetic solution if you inject it.

Inguinal hernia is much easier to do under local than general, injecting first in the subcutaneous tissue and then down in the canal before you cut. If you fill the inguinal canal full of a weak solution, you will have every structure differentiated and it will make the dissection easier.

Amputation of the breast is another operation that is in his experience easier to do with local than with general.

In the serious cases of gall bladder disturbance, where you need to do a colocystotomy and the patient can't stand general, you will be surprised how easy it is to make the opening down through the abdominal wall and manipulate the patient and the table so that the gall bladder will come right up in the incision.

Dr. Van Housen (Chicago): I would like to ask Dr. Harger if he uses the local anesthesia in carcinoma of the breast and malignant diseases, and if he feels there is any danger of transplanting or grafting the malignant disease; also what he does in cases of wide infection?

Dr. Beveridge (Oregon): I would just like to say a few words from the viewpoint of the patient. A few months ago I had an operation for double hernia, direct inguinal hernia on both sides, both sides getting very large, under local anesthesia. I certainly was very well satisfied with the experience. There was absolutely no pain in the cutting or suturing or any part of the operation. I expected pain when they came to pulling up on the sac, but there was no pain at any time worse than the hypodermic injection when the first solution was given. The advantages were that I was able to eat half an hour after I came from the table; didn't miss a meal. I was on the table over three hours, and for that kind of an operation, in the hands of a competent surgeon, one who understands giving a local anesthetic, I think it is greatly to be commended.

Dr. Harger (closing discussion): In answer to Dr. Van Housen's question, I have not used it in carcinoma of the breast, but it can be used, I am sure. I simply haven't had a case where I thought that I could get better results in that way.

In an infection like a felon, I simply inject around the base of the finger and then go ahead and clean out the felon just the same as though the patient were asleep.

With osteomyelitis of the forearm, I make an injection above the elbow. In an operation on the foot and on the ankle or heel, I make an injection subcutaneously completely around the leg. In foot operations, especially, I make an injection above the ankle. In some of those cases, I felt that it was wise to get some of the anesthetic near the main trunk, but never to dissect them out or pick them out and inject

As a personal experience, I had an operation myself last year under local anesthesia; that was one of the things that stimulated me to further endeavor. It brought this point to me, that in hernia work and abdominal work, I inject subcutaneously an elliptical area around the field of operation, and cut down to the peritoneum. Then I take an angular needle and run it along between the peritoneum and the overlying muscle and inject a little anesthetic around there. I believe that in some of those hernia cases unless you inject around the neck of the sac, the patient is going to suffer pain when the sac is manipulated. I still maintain that it is not necessary to inject into the line of incision either in the skin or the deep tissues. If there are any ill effects from it at all it might interfere with the healing.

In goiter work, I inject at the angle of the jaw and inject down to the clavicle and then under the chin and just above the sternum, and you are entirely outside the field of operation.

As for the technique of injection, most of you are acquainted with Braun on Local Anesthesia, and he gives a detailed description. I have not followed it closely, but his book is full of good information.

110.15

INTRAVENOUS PROTEIN INJECTIONS IN UROLOGY AND DERMATOLOGY

HARRY CULVER, M.D.
CHICAGO

Since 1913, when Bruck and Sommer[1] used intravenous injections of killed gonococci in the treatment of complications of gonorrhea, there has accumulated a considerable literature on the subject. They used special care in securing highly polyvalent gonococcal vaccines, and by so doing believed they were able to influence all such gonococcal infections specifically; this idea and method of treatment, though not generally adopted, had many adherents for three years.

Toward the end of this period, the nonspecific factors in the treatment of infections were being recognized. Müller and Weiss,[2] by the intragluteal injection of milk, secured results in gonorrheal complications that compared favorably with those of Bruck and Sommer, while Miller and Lusk[3] secured encouraging results in gonorrheal arthritis by the use of intravenous typhoid vaccine. In their series were four instances of acute gonorrheal arthritis, all of which received less benefit by this treatment than acute cases of other origin, although slow improvement was noted; one subacute gonococcal arthritis, and four of the five cases of chronic gonococcal arthritis were cured.

It has since been established[4] that gonococci, meningococci, colon bacilli and proteose preparations intravenously administered, all produce equally good results in gonococcal arthritis and epididymitis. In my first series of twenty-four patients with gonococcal arthritis, complete recovery or marked rapid improvement was observed in all but two instances. Eleven patients were treated with gonococci with one failure, and eleven patients with meningococci with one failure, while but two were treated with colon bacilli, and both recovered. In the epididymitis series were twelve patients, and all were apparently completely and permanently cured within a week, there being no difference in results produced with the gonococcus, meningococcus and colon bacillus.

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[1] Bruck and Sommer: München med. Wchnschr. **60**: 1185, 1913.

[2] Müller and Weiss: Wien. klin. Wchnschr. **29**: 249, 1916.

[3] Miller, J. L., and Lusk, F. B.: The Use of Foreign Protein in the Treatment of Arthritis, J. A. M. A. **68**: 2010 (Dec. 30) 1916.

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Many clinicians familiar with the therapeutic results of this method are convinced that the improvement or cure of the infection depends, in great measure, on the intensity of the reaction and on the processes associated therewith. Since any bacterial suspension is capable of producing the reaction, the readily accessible typhoid vaccine is frequently used for that purpose. On the other hand, I have used gonococcal protein almost exclusively, not that it is believed to have any greater curative value, but because its reaction characteristics have been more carefully studied.

Cecil[5] noted little improvement after intravenous proteins in seven patients with gonorrheal arthritis. Two of these patients received typhoid and five gonococci; and while all showed slow improvement while in the hospital, there is doubt in this author's mind as to the permanent benefit secured in gonorrheal arthritis by injections of protein intravenously. There are, without doubt, certain refractory instances of gonococcal joint infection, especially the severe acute cases; but even here I believe the incidence is not high. The best results are now being obtained by the simultaneous treating of the primary focus together with the intravenous protein injections.

In one military cantonment where intravenous injections of gonococcal protein were used in gonococcal epididymitis, the results were most gratifying. The cessation of pain was nearly always complete within twenty-four hours after a properly reacting protein injection, and the average stay in the hospital was from five to six days, at the end of which time there was usually a marked reduction of the local swelling, which reduction started with the subsidence of the pain. In some instances of gonorrheal epididymitis it is necessary to give a second injection to obtain the desired results. There are two distinct groups of such individuals: One apparently derives no subjective or objective benefit from the first injection, but may respond nicely to the second injection from twenty-four to forty-eight hours later; the other group obtains relief after the first injection, but it is only temporary. These patients also sometimes obtain complete and permanent relief after a second injection. If benefit is not secured in these cases after a second injection, it is not best to continue with this treatment.

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[5] Cecil, R. L.: A Report of Forty Cases of Acute Arthritis Treated by the Intravenous Injection of Foreign Protein, Arch. Int. Med. **20:** 951 (Dec.) 1917.

The primary infection, as the urethritis, prostatitis and seminal vesiculitis, while still present after this cure of the epididymitis, responds more readily, in most instances, to local treatment than other similar infections not so treated.

As this method was introduced with the opening of the aforementioned military camp, it was not found necessary to perform epididymotomy in a single instance of gonorrheal epididymitis, a most unique record for a military post where epididymitis is relatively common.

Very little, if any, effect is noted in orchitis of mumps or in nonspecific epididymitis after intravenous injections of protein, a fact that may prove to be of some diagnostic value.

In dermatologic practice, encouraging results have been noted in certain chronic skin lesions by the use of the protein reaction. Engmann and McGarry[6] obtained satisfactory results by the intravenous injection of typhoid bacilli in one case of psoriasis; marked improvement in six instances of lupus erythematosus, in one of exfoliative dermatitis, and in one of parapsoriasis; and slight improvement in one instance of dermatitis herpetiformis. A case of Darier's disease was made worse with the appearance of new lesions.

Scully[7] has reported success in the treatment of psoriasis by combining intravenous typhoid injections with proper local treatment. Eight cases of chronic soriasis were thus treated, and following the first or second injections the lesions became less inflammatory and less indurated, although there was no retrogression in the extent of the lesions and no new lesions appeared. When this was followed by the application of chrysarobin, the lesions entirely disappeared in from eight to sixteen days.

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In studying the reaction following the injection of various bacterial suspensions in gonorrheal patients, I used, as controls, nongonorrheal patients suffering from chronic skin lesions, as psoriasis, chronic eczema and recurrent pyogenic infections of the skin. Apparent temporary cures were obtained in three cases of psoriasis and two of chronic eczema, while permanent recovery was obtained in three instances of chronic pyogenic skin infection. Although all cases of chronic eczema and psoriasis had recurrences, the lesions were of a much milder type.

There have been no recent reports either to condemn or to sustain this method of treatment in chronic skin diseases. It would seem to be worthy of a trial in certain instances.

7 West Madison Street.

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PAPILLOMA OF THE URETER

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Primary neoplasms of the ureters are very rare, as evidenced by the few instances in medical literature and by almost complete absence of clinical or pathological records of such cases in large general hospitals. The difficulty in making an accurate clinical diagnosis together with the failure of making complete necropsis in all cases of death regardless of the apparent cause, no doubt, has tended to minimize the number of cases on record. Some of the known cases of ureteral neoplasm were incidental to acute infections which caused death and were discovered by complete organ examinations at necropsy.

The ureter, like other structures of the urinary tract, develops practically only neoplasms of epithelial origin. Speiss in 1915 was able to collect but twenty-four instances of primary epithelial ureteral tumors from the literature, including nine benign and fifteen malignant growths. Indeed, the ureter is more frequently involved in new growths secondarily, either by extension from the renal pelvis or the urinary bladder, in both of which structures these growths are quite frequently primary. While it would be hardly possible to state in which structure the tumor is primary in all such instances, only those are considered as true primary ureteral tumors which are confined to the ureter at the time of the examination, or present adequate clinical or pathological evidence supporting this assumption to justify such classification.

The rarity of benign epithelial ureteral tumor, together with a fairly typical clinical course and symptomatology of an available instance of such disease justifies this report.

A married woman, age thirty-five years, entered the hospital complaining of blood in the urine and severe colicky pain in the left side of the abdomen and back. Symptoms had been present intermittently for two years. Her initial symptom was pain in the region of the left kidney, associated with tenderness of this organ. This pain was deep and boring, sudden in onset and did not radiate; it disappeared as suddenly as it appeared and was followed by the appearance of blood in the urine. The hematuria, while really constantly present since the onset became intermittently profuse and was then associated with pain and tenderness of the left kidney.

Cystoscopy about one year after the beginning of symptoms established the facts that the bladder was normal and the blood was coming from the left ureteral orifice. Separated urines were negative for tuberculous or pyogenic infections and rentgenograms were negative for calculi.

Owing to a gradual increase in the frequency and severity of the attacks of pain and profuse bleeding, a left nephrectomy was done. The pathological report, from a reliable source stated that the kidney specimen showed a mild chronic diffuse nephritis. There was no evidence of neoplasm, stone or infection.

Following nephrectomy there were ten days of relief from symptoms, then bleeding returned associated with the most severe attacks of pain yet experienced. The character of the pain, however, had changed to a typical left ureteral colic and occurred with such frequency and severity that frequent hypodermics of morphine were necessary.

The patient came under my observation three weeks following the nephrectomy. There was then profuse hematuria and pain and tenderness along the course of the left ureter.

General examination was negative. The urine showed macroscopic blood but was otherwise normal. . The hemoglobin estimation was 75 per cent (Dare).

Cystoscopy. The urethra easily admitted a no. 24 instrument without pain or obstruction. The bladder tolerance was good, its capacity being 15 ounces. One bladder washing was necessary to get a clear medium. A blood clot was seen protruding from the left ureteral orifice, the right ureteral efflux was normal. Excepting for blood stained vesical mucosa about the left ureteral orifice, the bladder was normal. The blood clot of the left orifice was washed away and close inspection of this region revealed no new growth. A no. 6 skiagraphic ureteral catheter was passed up the left ureter for 23 cm. before obstruction was met. Bright red blood dropped steadily from the ureteral catheter. An ureterogram demonstrated that the ureter extended about 4 cm. above the obstruction. There were no tortousity, dilation or filling defect of the ureter; neither were there any shadows suggesting calculus.

These findings strongly indicating ureteral neoplasm, complete ureterectomy was advised and accepted.

The ureter was readily exposed extraperitoneally by extending the previous nephrectomy incision. The ureter was ligated and removed near its entrance into the bladder wall. It did not appear indicated to remove the intramural and intravesical portions of the ureter as there was no evidence in this instance of tumor involvement here although they are the most frequent sites of tumor growth.

Surgical specimen. (4 cm. of the ureter were removed with the kidney at the first operation).

The section of the ureter removed measured 24 cm. Upon opening the ureter longitudinally for its entire length it is seen that the mucosa is blood stained throughout its course. Four centimeters from its upper end there is a distinct papillary growth (fig. 1) which consists of one long villus 3 cm. in length and many rather indistinct shorter ones springing from the base of the long growth. The adjacent mucosa, to which the pedicle is attached, is normal in appearance and consistence. A second small sessile growth is present about 1 cm. below it.

The ureteral musculature is very much thickened throughout; otherwise there are no further appreciable changes.

Microscopic examination of tissue. The mucosa of the ureteral wall is directly continuous with that of the neoplasm (fig. 2) and at no point is there any malignant tendency. The mucosa of the tumors consists of several layers, the most superficial of which is made up of flattened cells; as the basement membrane is approached the cells become columnar just as is seen in the normal ureter. The submucous tissue of the ureteral wall is connected directly with the framework of the tumor. This tissue carries large blood sinuses both in the ureteral wall and tumor. There is a considerable inflammatory reaction of all of the tissues examined microscopically, as evidenced by polymorphonuclear and round cell infiltration which extends superficially into the ureteral musculature.

After history. The convalescence was short and the clinical result striking. The bleeding stopped at once and eight months after the second operation there had been no symptoms referable to the urinary tract.

A complete search of the literature has been made and but 16 instances of benign epithelial new growths of the ureter were found. A table presenting the essential features of all the reported cases is shown (table 1).

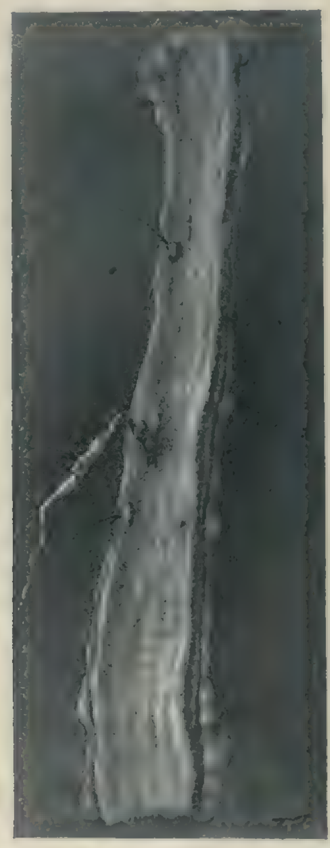

Fig. 1. Inner Aspect of Opened Ureter

Arrows pointing to the three small papillary neoplasms

As in neoplasms elsewhere there is no apparent etiology in most instances; however, of the 16 collected instances 3 presented stone intimately associated with the neoplasm, 1 had partial ureteral duplication, 1 ureteral diverticulum at the site of the tumor and 1 had a duodenal renal pelvic fistula presumably caused by stone. It is seen that just one-third of these presented cases have other local lesions which may be etiological factors. Again the neoplasm may be the primary cause of some of these acquired conditions.

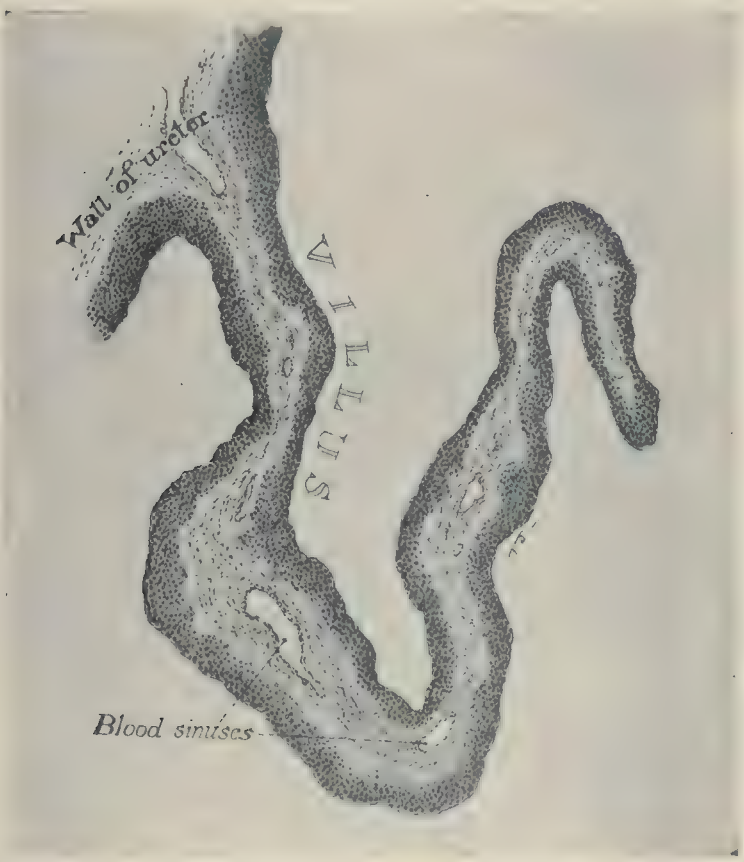

FIG. 2. PARTLY RECONSTRUCTED DRAWING OF A LOW POWER MICROSCOPIC APPEARANCE OF THE LARGEST GROWTH, EMPHASIZING THE RELATION OF ITS VARIOUS TISSUES TO THOSE OF THE URETERAL WALL

The histological structures of these growths is similar to epithelial neoplasms elsewhere along the urinary tract and are multiple in a great majority of cases. As in bladder papillomas the tumor itself may be benign with malignant qualities at the

TABLE 1

An outline of the main features of all the cases of ureteral papilloma reported

REPORTED CASES	SEX	AGE	SYMPTOMS			COEXISTING DISEASE	HOW DIAGNOSED		REMARKS
			Hematuria	Pain	Tumor		Clinically	Autopsy	
Rayer, 1840	M		+		+	Ureteral stone	Operation		
Thornton, 1885	F	32		+	+	Ureteral stone	Operation		
Neelsen, 1888	M	57				Partial duplication right ureter		+	Tumor at bifurcation of ureter
Jeben, 1894	F	42			+	Pyothorax		+	
Jona, 1894	M					Pneumonia		+	Tumor at edge of ureteral diverticulum
Kaufmann, 1896	M					Duodeno-pelvic fistula	Operation		
Poll, 1899	M	41	+	+	+			+	
Heresco, 1901	M	32		+			Cystoscopic		
LaDentu, 1899	M	33		+	+	Ureteral stone	Operation		
Lancereaux	F	64		+	+			+	
Muzio, 1903					+			+	
Mackenroth, 1903					+		Cystoscopically and operation		Ureteral transplant, recovery
Brunet, 1907	F	60	+				Cystoscopically and at operation		Ureteral transplant, recovery
Suter, 1910	M	56	+				Operation		
Praetorius, 1914	F	67	+		+		Operation		
Spiess, 1915		55	+				Operation		

base, also apparently benign growths of the ureter have resulted in malignant recurrences and metastases as seen in Battles and Pantaloni cases.

The kidney tissue often shows sclerosis and sometimes diffuse nephritis, which lesion was present in my case. These renal lesions occur in both septic and aseptic instances due, it is believed to the elimination of toxins produced by the tumor itself.

Ureteral papilloma have a tendency to be located in one of three manners, (1) the entire ureter involved with the pelvis and bladder, also (2) pelvis and first few centimeters of the ureter involved, (3) lower part of pelvis and upper part of ureter and lower centimeters of ureter with intervening part being normal. The case here presented belongs to the second class but has no renal pelvic involvement.

Of these 16 collected cases and the case here reported 14 were clinical and 3 were discovered at autopsy. The clinical cases presented essentially three symptoms; tumor, hematuria and pain. Nine of the 17 instances or 53 per cent had definite tumor mass and in 2 cases this was the first sign and the only complaint. Hematuria was present in 7, or 41 per cent of the cases and in 2 cases this was the only complaint. The hematuria is spontaneous, of variable duration and uniformly colors the urine. The bleeding is modified by rest, it is frequently painless but it is not rare to have it accompanied by ureteral colic. In 6 of the 17 clinical cases this occurred when the bleeding was profuse. Pain was present in but 6, or 35 per cent of the cases, and it was the only complaint in 1 case.

The tumor in all instances is that produced by hydronephrosis or hematonephrosis and not due to the presence of the neoplasm itself. The presence of hematonephrosis is considered by some to be of considerable diagnostic importance.

The pain is of two types, the most common type is that associated with intrapelvic pressure and is therefore confined to the region of the kidney and does not radiate. Such was the first pain experienced by my case. The second type of pain is colicky in nature, radiates down the course of the ureter and is caused by the passage of blood clots; a condition which occurred in my case following nephrectomy.

But two of the clinical cases collected complained of other urinary symptoms and in both instances it was frequency of urination due to a superimposed urinary infection.

The diagnosis of renal tumor or stone is usually made. It is possible in most instances to rule out renal or ureteral stone, but there is no available method to make an absolute differentiation between renal and ureteral tumor unless there is evidence of ureteral obstruction as determined by the ureteral catheter. Even here the diagnosis may be incomplete as tumor obstruction in the ureter is frequently associated with renal pelvic involvement which may be primary.

Two cases were diagnosed as ureteral tumor by cystoscopy; those of Heresco and Mackenroth, but in both instances the tumor mass could be seen protruding from the ureteral orifice. In Brunet's case the bladder was opened to treat a papilloma about the ureteral orifice. Palpation of the lower part of the associated ureter suggested its involvement. In all the other 12 clinical cases the diagnosis was either made at secondary operation which occurred five times or after death either following or during the primary operation. The primary operation was nephrotomy four times and nephrectomy once. Suter's case of primary nephrotomy followed by nephrectomy had to have a third operation of ureterectomy to cure.

As the tendency for all of the neoplasms is to become malignant it is obviously indicated to do as complete a removal as possible. If the tumor is near the bladder, ureteral resection and transplantation can be done as was done in Mackenroth's and Brunet's cases. This method, while apparently successful in these two instances may be very incomplete and call for a second operation of ureterectomy and nephrectomy for tumors above the point of resection. Considering the seriousness of the latter procedure it would appear justifiable to do early ureteral resection and transplantation for ureteral neoplasms near the bladder.

For all tumors above this point complete nephrectomy and ureterectomy is indicated unless there are serious contraindications.

7a 17

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DISLOCATIONS AND FRACTURE-DISLOCATIONS OCCURRING AT THE ACROMIO-CLAVICULAR ARTICULATION*

R. W. McNealy, M. D.,

CHICAGO

The frequency of these dislocations and fracture dislocations with their attendant difficulties of management prompts me to present this paper to the society.

In discussing these cases with men who do considerable casualty work, I find that they, too, have been impressed by the difficulties encountered in getting good results in the severe types.

I believe it would be well to first consider the anatomical peculiarities of the acromio-clavicular joint. This joint belongs to the group of arthrodial diathroses, that is, it has the following characteristics: (a) movement (principally gliding of opposed surfaces) which is rather limited; (b) the uniting structures consist of a series of retaining ligaments; (c) a very small joint cavity limited by the capsular ligaments; (d) a constant synovial membrane; (e) hyaline cartilage covering the surfaces of the opposed bones.

The ligaments which surround the acromio-clavicular joint form a complete capsule with rather stronger fasiculi above and below the joint which are named the superior and inferior acromio-clavicular ligaments. An incomplete wedge shaped meniscus is attached to the joint capsule and may divide the synovial membrane. The movements of this joint are limited by the capsular ligaments and the conoid and trapezoid ligaments. These two latter ligaments; the conoid situated internal and slightly behind the trapezoid, which attaches itself to the upper surface of the posterior half to the trapezoid ridge on the under surface of the acromial end of the clavicle; set a limit upon the movements of the scapula at the acromio-clavicular joint. The trapezoid especially prevents the acromion process of the scapula from being carried inward below the outer end of the clavicle, which is the most frequent deformity associated with the injuries under discussion.

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*Read before the Chicago Medical Society, Jan. 25, 1922.

Etiology and Mechanism: These dislocations and fractures are most common in middle life, especially in laborers. True simple dislocations are most common in the younger individuals, while the fracture-dislocations, as would be expected, are mostly in older individuals.

The fractures are usually of the tearing variety due to the ligamentous attachments carrying with them fragments of bone at the points of their insertions. The violence is usually directly applied to the outer end of the scapula either by a fall or blow. Rarely is the violence indirect as by muscular exertion.

Pathology: Subluxations are comparatively frequent. The capsular ligament is torn and slight displacement occurs.

Complete luxations are very distressing accidents and are associated with marked and typical shoulder deformities (Fig. 2). Here the capsular ligament is torn across and the acromion process of the scapula inserts itself beneath the outer end of the scapula, by reason of the fact that the trapezoid ligament is torn loose from the trapezoid ridge of the clavicle. The joint meniscus is carried along with one or the other joint surface and may insinuate itself between the bones rendering reduction very difficult. Likewise the torn ligament ends may curl back into the joint, making complete reduction impossible, the difficulties here reminding one of a fractured patella.

In fracture-dislocations we have the same clinical picture as far as deformity is concerned, and in addition we have fragments of either the clavicle or the scapula attached to the torn ligaments. These fragments are often small and escape notice in casual x-ray examination, yet they are often very troublesome so far as treatment is concerned. The more marked fractures present little in addition to the greater signs of local trauma. Compound fractures are uncommon in this group.

Injury to the brachial plexus as a result of stretching with consequent paresis or paralysis has been a troublesome complication in some of these cases.

Signs and Symptoms: The patient usually gives a history of having fallen or having been struck on the shoulder. Pain and partial loss of function are complained of. It is especially hard for these patients to lift a weight from the floor.

The deformity is quite characteristic and is produced by the outer end of the clavicle riding above the acromion process of scapula. The shoulder of the affected side droops. In the fracture cases crepitus can often be elicited.

Treatment: Subluxations give little cause for anxiety except when they are complicated by other lesions. A Sayre or Stimson "Figure 8" dressing with a firm pad over the acromio-clavicular joint will give very good results with little discomfort to the wearer. Bevan recommends a molded felt splint applied to the forearm and a Martin bandage passing under the flexed arm over the shoulder with a pad over the site of dislocation. A sling supports the elbow and forearm. (Fig. 1. This illustration was taken from Dr. Gatewood's article in the *Chicago Clinics.*)

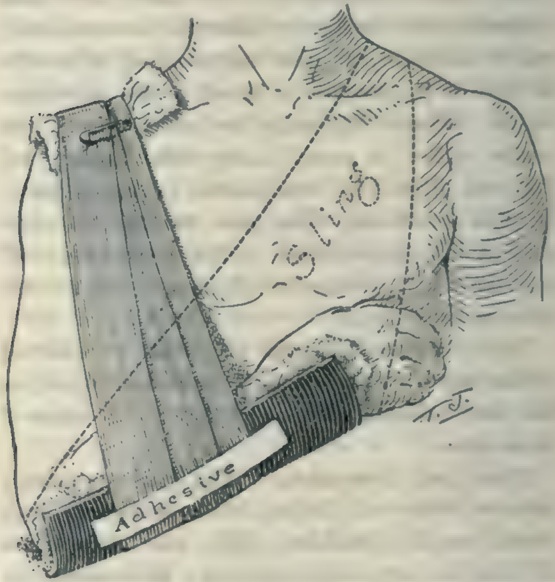

Fig. 1. Dislocation reduced and immobilization attempted by means of the molded felt splint, Martin bandage, and sling.

In luxation or complete dislocation difficulties are met, in first securing proper reduction, and secondly in maintaining reduction after it has been accomplished. The same is true to even a greater degree in the fracture-dislocations.

The accessibility of the acromio-clavicular joint coupled with the comparative freedom from serious consequences following infection seem to favor operative intervention in those cases wherein complete reduction cannot be maintained by retention appliances.

A number of methods have been employed with variable degrees of success in these cases. I consider it worth while to discuss briefly a few of these methods.

1. The Parham-Martin band has the following disadvantages: (a) the opening in the two fragments must be of considerable size to admit the band; (b) the large size of the band for such frail structures; (c) tightening the band is likely to produce splitting of bones; (d) removal of band requires considerable exposure and operative effort.

2. Ryerson in the *Chicago Clinics* described a very ingenious method of holding the bones in apposition by means of a rolled cord of facia lata. This method was quite successful in the hands of Dr. Ryerson but has the following disadvantages: it is difficult to secure facia tightly enough to prevent some slipping of opposed surfaces; the use of such a bulk of matter in this subcutaneous location is questionable in its application.

3. Plating and nailing have both been suggested by different writers but, I believe, can be discarded on the ground that motion would be too greatly inhibited. One must always bear in mind that there is a fairly wide range of motion in the acromio-clavicular joint.

4. Both Kangaroo tendon and Phospho-bronze wire have been tried but I have convinced

myself that they are not as suitable as the piano wire.

5. I have been particularly well pleased with the following technique of wiring which I have used in recent cases:

Incision: A crescentic incision about two and one-half inches long placed about one-half inch beyond the outer end of the displaced clavicle. The center of the concavity being opposite the most marked elevation produced by the acromial end of the clavical. The skin incision is deepened to the capsule of the acromio-clavicular joint. An attempt is made to avoid blunt dissection and hand contact.

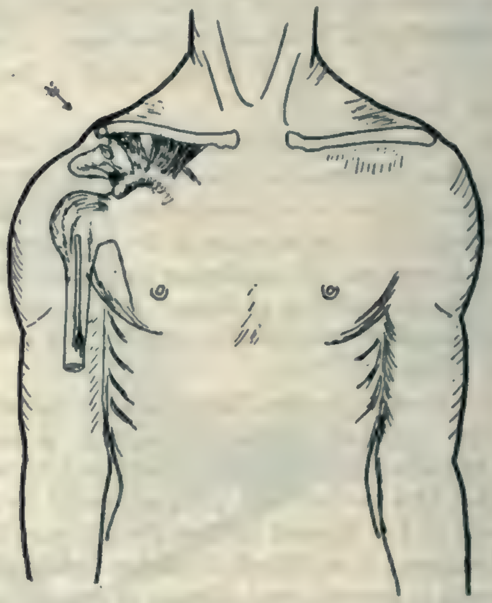

Fig. 2. Arrow indicates characteristic deformity occurring in dislocations and fracture-dislocations at the acromio-clavicular articulation.

Debridement: The joint exposed, all torn tags of the ligaments about the joint are carefully clipped away. The joint meniscus and small fragments of either clavicle or scapula are excised.

Beveling of Clavicle: If difficulty is encountered in retaining the scapula on a level with the clavicle, I bevel the upper surface of the acromial end of the clavicle so that when the two bones are closely approximated the clavicle prevents the scapula from slipping under its outer end. Fig. 3.

Wiring: Strong piano wire is used. Holes are drilled in the outer end of the clavicle about one half inch apart, and about the same distance from the articular surface of the bone. Two holes are likewise drilled in the acromial end of the scapula. These holes are usually about three-fourths of an inch apart and about the same distance from the articular facet. In tightening the wires it is well to manipulate the arm first to produce good reduction and then gradually tighten the wires alternately. Care should be exercised so that the wires are not twisted until the tension is so great that slight movement causes a snapping of the wires.

Suture of Ligaments: The writer has come to the conclusion from his own observation and the reports of others, that little is to be accomplished by trying to suture either the capsular ligaments or attempting a repair of the conoid or trapezoid ligaments. It suffices, after wiring, to apply three or four interrupted sutures to the ligaments and facia to cover the joint cavity.

Skin Closure and Dressing: The skin is closed with No. 1 catgut. The use of absorbable skin suture relieves one of the necessity of removing the retention apparatus. It can be readily seen that this is a decided advantage. A small fluff is fixed with adhesive directly over the suture line.

Retention Dressings: A Velpeau dressing is applied with the arm flexed and the palm of the injured side near the opposite shoulder.

It is well to thoroughly pad the elbow and the hand, preferably with felt. A very light plaster of paris dressing is placed over the Velpeau dressing. This plaster jacket is a decided advantage since it serves to better immobilize the injured part and, best of all, it prevents the loosening and slipping of the gauze Velpeau, which is very trying where the patients are young and not especially tractable.

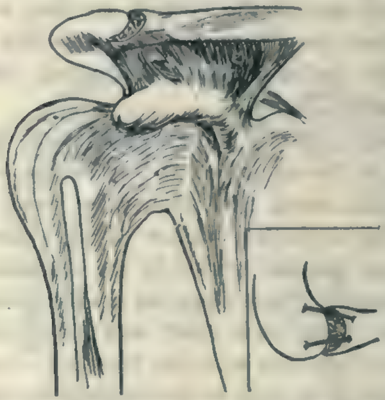

Fig. 3. Drawing shows manner of beveling clavicle to prevent acromial end of the scapula from slipping beneath the outer end of the clavicle. Insert shows position of wires.

After Treatment: At the end of five or six weeks the cast is removed and shoulder examined. If the x-ray is favorable, wires are removed under local anesthesia. If note is made at the time of closing of the skin wound, it is very easy to exactly locate the wires with reference to the skin sutures. No trouble and no pain is experienced in removing these retention wires. One stitch will close the incision used for removing the wires. Light exercise may be immediately instituted.

SUMMARY

1. Dislocations and fracture dislocations at the acromio-clavicular joint are common industrial accidents.

2. Fracture-dislocations are more common than we have been led to believe.

3. Fracture-dislocations present the greatest difficulty in management.

4. From an economic, as well as from a cosmetic standpoint, operation in the difficult cases is followed by very gratifying results.

5. Anatomical relations render this joint favorable for such operative treatment.

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ACUTE ANEURYSMS.*

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CHICAGO, ILL.

No apology need be offered for presenting the subject of aneurysms at this time. As an aftermath of the war they will be found to be of more frequent occurrence, due either to an increase in the number of syphilitic infections or to trauma of the blood-vessels.

As a rule, aneurysms develop by gradual dilatation of a portion of the arterial wall which is either diseased or weakened by trauma. There are, however, a goodly number which may hardly be said to come on gradually. Recent experience or attention to current surgical literature has familiarized most of us with the traumatic aneurysms and the arteriovenous aneurysms which develop as a result of bullet or shell fragment injury to the coats of blood-vessels. These two types, in many ways similar to the cases presented in this paper, present problems peculiar to themselves and must be omitted in the present discussion.

The cases which form the basis for this paper occupy a rather unique place in the classification of aneurysms, and in using the term "acute aneurysm," the same liberty is taken as in the use of the oft criticized yet familiar term "acute abdomen."

Brief histories of a few cases may bring out the interesting features of these rapidly developing vessel disturbances and facilitate a closer study of this particular group.

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*Read before the Illinois State Medical Society, May, 1921.

Case. 1. L. S., a colored male, aged 38 years, was admitted to my service Feb. 26, 1920. Ten days previous to this, while standing at his work, he felt a slight pain on the inner side of his right thigh, and on examination he discovered a small nodule which he took to be a swollen gland.

During the next three or four days this nodule rapidly enlarged, until by the eighth day it was as large as a golf ball. A throbbing sensation was present in the swelling and a pain extended down to the knee. On the morning of the tenth day, while standing at a counter, he experienced a stabbing pain in the leg, became dizzy, and fell to the floor. On admission to the hospital his right thigh measured 32 inches in circumference and gave a distinct expansile pulsation on palpation. The left thigh measured only 22 inches in circumference.

The patient's previous history presents little of interest save the fact that during the summer preceding he worked in an ice cream plant where in handling the crushed ice it was his custom to use the inner side of his right thigh to brace against the handle of the shovel. He uses tobacco and has been a moderate user of alcohol. He denies syphilis. Wassermann proved to be a 4 plus reaction.

Operation:. Under ether anesthesia an incision similar to the usual inguinal hernia incision was made and the external iliac vessel was ligated with a broad silk tape. A second incision was then made over the course of the common femoral artery. Several pints of dark blood and clots were evacuated and the ruptured aneurysm sac exposed. The upper limit of the sac was just distal to the profunda femoris. Double ligation with silk was made at each extremity of the sac and the sac dissected out. The temporary ligature of the external iliac was then removed and the first incision closed in layers. The second incision was closed with interrupted stitches and a small cigarette drain inserted to drain the serum accumulation.

Post-operative course: Anti-syphilitic treatment was immediately instituted and pushed to point of tolerance. Evidences of peripheral gangrene were apparent after one week and amputation above the ankle became necessary. An excellent weight-bearing stump was secured. The pressure of the extravasated blood probably contributed greatly to the production of the gangrene.

Case 2. J. O., Russian laborer, aged 45 years, was admitted to Cook County Hospital August 27, 1917, with a diagnosis of abscess of the thigh. The patient stated that two weeks before admission he first noticed a swelling of the right thigh accompanied by pain. No history of recent trauma nor infection was given, but the patient volunteered the information that his using of his right thigh to support a wheelbarrow in his daily work might have some bearing on his present complaint.

On examination a mass presented on the inner and posterior surface of the thigh. The mass was round, smooth, and seemed softer in spots. No marked tenderness was present and no decided pulsation could be felt.

Operation: Temporary ligation of the femoral artery in Hunter's Canal was first accomplished, then the tumor mass was incised and the blood clot turned out. Double ligatures were then applied above and below the sac. The sac was not dissected out in this case, but was packed with gauze. Microscopic examination of a section of the sac wall showed no characteristic changes.

Post-operative course: The wound drained for some time. No gangrene appeared and the patient left the hospital two months later.

Case 3. L. N., colored, male, aged 49 years, employed as a laborer, was admitted to Cook County Hospital, February 2, 1920, complaining of pain in the right knee, swelling of the leg, and difficulty in walking. He stated that eighteen years ago he fell and injured his right knee, but had had little trouble with leg until three weeks ago, when his leg began to swell very rapidly and to give him severe pain. He had a chancre twenty years ago and was treated for two weeks.

Examination of right leg showed some edema below the knee. There was an expansile pulsating tumor in the popliteal space which was as large as a hen's egg. Further examination showed the patient to be suffering from a popliteal aneurysm. He also had an aortic aneurysm. The patient was very uncomfortable and restless and insisted on leaving the hospital before any treatment could be instituted.

From the foregoing histories certain facts arrest our attention and some of these we shall discuss very briefly.

Etiological Factors. 1. Trauma. Constantly recurring slight trauma seems to be as potent as does a single severe injury. The sites of these vessel injuries apparently serve as points of lowered resistance to future infections. Barwell was familiar with the importance of oft-repeated slight trauma and offered this in explanation of the greater frequency of popliteal over brachial aneurysm. I may also mention here that the trauma may antedate the aneurysm by many years, as was the fact in Case 3.

2. *Syphilis.* A history of syphilis is present in a large majority of such cases, but even where no history of a chancre is obtainable, the Wassermann test is usually positive. Active lesions of syphilis are sometimes present elsewhere on the body. If I were to express my opinion unreservedly I should designate this particular group of cases as *arteriectasis due to localized arteritis syphilitica.*

3. *Alcoholism.* Probably has some part in the causation of arterial degeneration and may possibly have a part in these rather rapidly developing cases. Martinet, in discussing aneurysms of the aorta, remarks that the "ethylate of syphilis" (syphilis plus alcoholism) is particularly dangerous.

4. *Stress and Strain.* These are probably determinary factors which only become prominent when arterial disease is present.

Clinical History. It is not surprising that a number of errors in diagnosis are recorded in this group of cases because we have been taught to regard aneurysms as of slow development extending over months or years. How different are the pictures presented by this group.

Rheumatism, hernia, abscess and neuralgia are not uncommon diagnoses made in the atypical aneurysms.

Symptoms. After development these cases are in no wise different from the regular types of aneurysm with which we are familiar. The clinical manifestations are dependent upon the physical characteristics of the aneurysmal sac and the pressure exerted upon surrounding structures.

Course and Termination. The only point of interest here is the tendency of these rapidly developing types to spontaneous rupture.

Pathology. We were able to secure a specimen from the arterial wall of one case which we operated on. The specimen was excised from the proximal part of the aneurysmal sac near the normal vessel. The microscopic examination showed a dense, round-celled infiltration of the vessel layers. Hyaline degeneration and marked round-celled proliferation was noted surrounding the vasa-vasorum. Warthin has described in detail specific changes in arteries. I am sorry that I did not stain my section for spirochetæ as Manouilian was able to demonstrate the spirocheta pallida in several cases of aortic aneurysm. In his cases the spirochetæ were found in much the same relation as occur in typical gummata. It should be stated that the acute aneurysms are always saccular in type, the vessel wall balooning out as does a weak area in an overinflated inner tube. Early the sacs may be completely lined by endothelial cells, but tearing and shredding of the intima soon occurs and the media and adventitia may likewise give way, creating a dissecting or false aneurysm.

Prophylactic. It is surely not out of place to emphasize at this time the necessity of early and thorough anti-syphilitic treatment as an insurance against these formidable vessel changes. It might be well to stress the fact that where a patient is syphilitic, relatively slight traumas to the vessel walls may lead to disastrous results.

The history of one of my cases emphasizes the necessity of examining the blood of patients who have had fractures, particularly where the fragments of bone might have traumatized neighboring large vessels.

Active. 1. Medical. Although I doubt the value of medical treatment alone in any aneurysm, it may have a certain value when combined with proper surgical procedures. Castillano in a recent communication describes a clinical cure following rest in bed, milk diet, and a weekly injection of 60 c.c. of a gelatinized serum. Mercurial treatment should be given all cases where a suspicion of syphilis exists.

2. *Surgical.* I have no intention of going into detail regarding the advantages and disadvantages of the various methods of treating aneurysms. I shall confine my remarks to a few facts pertinent to this particular group of cases.

1. Where rupture of an aneurysm has occurred immediate operation is imperative. Where possible means of temporary compression should be resorted to while the patient receives an infusion of normal salt solution or a transfusion of blood from a suitable donor. It should be borne

in mind that bleeding into the tissues of an extremity greatly increases the danger of subsequent gangrene.

2. *Treatment of aneurysmal sac.* These rapidly developing sacs are not suited to endo-arteriorraphy after the method of Matas, on account of the friable condition of the vessel walls. Where rupture has occurred, proximal and distal ligation with dissection of the sac, is probably the safest course to follow.

Ligation of the corresponding vein. Recently many surgeons (Halsted, Drummond, Neuhof and St. John) have advocated ligature of the accompanying vein. LaRoque in the *Annals of Surgery* states: "There is a genuine reason for believing that vein ligation favors the development of collateral vessels and through retention of blood volume and pressure aids enlargement of vessels already present." Dobrovolskaia in his discussion of wounds of blood-vessels states that in eighteen cases in which the vein was simultaneously ligated no advantage was apparent. In one case there was aseptic gangrene of the leg muscles after ligation of the popliteal vein, although the foot remained normal, as the subcutaneous venous system apparently maintained its circulation. With such diametrically opposite views it leaves one in doubt about vein ligation. Further work and careful observations may clear up this point.

Post-operative Management. I can do no better here than quote from Flannery and Tormey: "The wound should have a large, soft, sterile dressing applied. The extremity allowed to lie in its natural position. Splints are contraindicated. Heat should be supplied by therapeutic light and not by hot water bottles for obvious reasons."

CONCLUSIONS.

1. Rapidly developing aneuryams are not uncommon.
2. The treatment is as yet not standardized.
3. Syphilis should be suspected in all cases and treatment immediately instituted.
4. The friable condition of the arterial walls contraindicates plastic vessel work.
5. Delay for the purpose of increasing collateral circulation is not justifiable.
6. Early operation is desired where tissues are infiltrated with blood.

DISCUSSION.

(Abstract.)

Dr. Carl B. Davis, Chicago, agreed with the speaker excepting about the collateral circulation. He felt that giving these patients a little more time after the aneurysm first appears would save more people. A few weeks ago a man was injured by a piece of metal which was shot into his neck, the internal or external carotid being injured. After three weeks he developed a rapidly forming aneurysm. Because of softening of the brain with 12 per cent. mortality in ligation of the carotid, we delayed between three and four weeks and then ligated the common carotid.

Dr. E. H. Weld, Rockford was especially interested in the fact that these cases are frequently luetic and the particular reference that was made of the importance of looking into the luetic history in fracture cases. It should be very common practice to make a Wassermann test in every fracture case.

Dr. R. W. McNealy, Chicago (closing): In answer to Dr. Davis' question about collateral circulation, the work that has been done on the vessels in the collateral circulation is very interesting and would really take up all the time to discuss it alone. The belief in the formation of this collateral circulation has been given a great deal of study, but no one has given a demonstration of blood flowing uphill in the arteries. That was the old-fashioned theory of collateral circulation in the anterior vessels of the aorta. In the circle of Willis we know these vessels form a perfect circle. There are certain vessels in the posterior group which really inosculate and where a direct communication exists, but the particular thought in the collateral circulation is the old idea of anastomosis, about the hip for instance, where the vessels terminate in small capillary areas. It is a question whether they really form any sort of synapsis, as we speak of in neurology. That has never been demonstrated. In the vessels such as Dr. Davis mentions where there is a definite circle there should be no question about the advisability of waiting before ligating.

In answer to Dr. Weld's question about dissection or compression, I believe in the femoral—and the greatest mortality occurs in the lower femoral, if you have ever seen one of these ruptures and seen the thigh as tense as it is and measuring, as in one I saw, 32 inches in circumference, I believe you would rather not attempt compression unless you were sure, because the patient is in a very anemic condition from loss of blood and you feel that you should conserve every drop of blood and compression on an area that is all edematous as is found here, is rather questionable. You do not feel at all sure that you would have a complete compression of the femoral artery. If you make the compression and the assistant slips, you lose a great deal of blood and you lose the patient on the table before you can make more compression. It is absolutely impossible to grasp those vessels with the artery forceps because they are so friable. I feel you should go in above where you know you have a better field and can feel perfectly secure and where there is less danger of losing a great quantity of blood.

In regard to dissecting out the sac, if you do not dissect out the sac you have this ruptured artery at the bottom of the wound, which is very likely to become infected. I think if you follow out the method of war work—debridement; and get rid of all the loose tissues, you will get better results.

Fr. 19

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BLOOD TRANSFUSION IN THE NEW BORN*

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When such conditions as hemophilia, internal hemorrhages or severe anemia from unknown causes appear in the new born, the treatment that should be instituted is blood transfusion.

This procedure is usually looked upon as requiring a great deal of skill and special instruments and consequently, where large hospital facilities are not available, is not performed as frequently as in the large medical centers. I desire to describe the indirect method of blood transfusion, which produces the same results as the direct method, and can be performed by any physician having the average amount of surgical skill, and in the private home if necessary. The instruments necessary for the operation are:

2 aspirating needles of about 18 guage to be used for the donor.

2 aspirating needles of about 20-21 gauge to be used for the recipient (2 needles should always be on hand in case one becomes plugged.)

1 graduate.

1 glass rod.

1 graduated glass cylinder (similar to what is used in salvarsan injections).

1 small scalpel.

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*Read before the Stockyards Branch of the Chicago Medical Society, December 9. 1920.

1 pair fine tissue forceps.
Several small artery forceps.
1 pair scissors.
Several cutting needles.
Ligature carrier.
Catgut No. 00.
Silkworm gut.
2.5 per cent. sodium citrate solution.
Normal saline solution.
Rubber tubing tourniquet.

Technique. In the new born the donor is usually the mother or father for which blood the hemolysis test is not necessary. The median basilic vein of the donor is entered with the aspirating needle and about 100 c. c. of blood is collected in the graduate, in which 5 c. c. of the citrate solution is first added and then 5 c. c. more after 50 c. c. of blood has run in. Constant stirring of the mixture with the glass rod is done by the assistant. An incision in the bend of the elbow of the infant is made after a tourniquet is applied to the upper part of the arm, which incision should be at least ½ inch long and extending about 1 cm. above the bend of the elbow. By careful dissection the vein is isolated, and the needle inserted into the vein in the upper part of the wound as here the vein is largest in diameter. The largest gauge needle that will enter the vein should be used, as the distension of the vein by the needle renders the freer flow of the transfused blood. The tourniquet is now removed from the arm. From the graduate cylinder normal saline is first run into the vein after all air in the apparatus has been expelled, and when it appears that the saline is running freely into the vein, the blood is poured into the cylinder. During the transfusion the infant should be watched for an acute dilatation of the heart. After the transfusion the vein of the baby is ligated and the skin wound closed with silkworm gut.

Conclusions. There are several important steps in the operation, namely, making the incision high enough in the arm of the baby and using a needle large enough to distend the vein and permit free flow of the blood.

The external jugular vein and the longitudinal sinus entered through the anterior fontanelle is sometimes used to transfuse the blood into, but this complicates the operation as compared to the arm transfusion.

The results obtained by blood transfusion are on the whole very satisfactory in the new born.

I desire to make it clear that I do not claim originality for this method of transfusion, but desire to call attention to its marked simplicity, and its remarkable results, and urge the more frequent use of it.

A Study of Streptococci from Postgonorrheal Prostatitis by a Quantitative Method of Agglutination and Absorption

RUSSELL D. HERROLD

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A STUDY OF STREPTOCOCCI FROM POSTGONORRHEAL PROSTATITIS BY A QUANTITATIVE METHOD OF AGGLUTINATION AND ABSORPTION

Russell D. Herrold

From the John McCormick Institute for Infectious Diseases, Chicago

This study includes 28 strains of streptococci from a series of chronic postgonorrheal infections of the prostate, 4 strains of streptococci from the normal urethra and 16 from various sources outside the genito-urinary tract (feces, nasopharynx, sputum of chronic bronchitis, empyema, tonsillitis, pleural fluid, scarlet fever throat, puerperal sepsis, and mastoid infection).

The general grouping of these streptococcal strains according to their action on blood agar is indicated in table 1.

Rabbits were immunized with 6 selected strains (table 1), all of which were found present in 2 successive cultures of prostatic exudate. Three of these were typical streptococci of the viridans type, causing the alpha type of hemolysis of Smith and Brown; one caused a narrow zone of hemolysis corresponding (alpha prime); the other two were typical hemolytic streptococci causing the wide hemolytic zones (beta). The rabbits were injected once a week with a 16-hour growth on ascites phosphate agar. Suspensions were made in salt solution and heated for 30 minutes at 53-56 C. The first injection was ¼ of a slant intravenously and with each succeeding injection the dose was increased by that amount until a maximum of one slant was given. The animals were bled and tested on the seventh day after the fourth injection. In the case of those animals whose serums did not contain sufficient agglutinins, the injections were continued at weekly intervals until a satisfactory titer was obtained, serum being taken for tests preceding each later inoculation.

The green streptococci generally seemed to produce agglutinins more readily than the hemolytic.

A standard technic for agglutination was used which gave consistent results on repeated trials.

A solid medium was used because homogenous suspensions then could be obtained regularly. The basis of this medium was nutrient agar in which dibasic sodium phosphate was substituted for sodium

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TABLE 1

Agglutination Titers of Antistreptococcic Serums Before and After Absorption

Source of Streptococci	Classification of Streptococci According to Growth on Blood Agar	No. of Strain	Agglutination Titers of Serums for Prostatic Streptococci						Agglutination Titers of Serums for Homologous Prostatic Streptococci After Absorption						Nos. of Streptococcus Strains With Which Serums Were Treated
			Serum Against Strain 1	Serum Against Strain 12	Serum Against Strain 13	Serum Against Strain 14	Serum Against Strain 20	Serum Against Strain 22	Serum 1	Serum 12	Serum 13	Serum 14	Serum 20	Serum 22	
Prostate	Viridans-alpha	1	3200	400	100	10	0	0	0	4000	1200	800	400	600	1
Prostate	Viridans-alpha	2	3200	400	10	10	0	0							
Prostate	Viridans-alpha	3	3200	400	100	10	0	10	0	4000	800	800	400	800	3
Prostate	Viridans-alpha	4	3200	400	100	10	0	0							
Prostate	Viridans-alpha	5	3200	400	10	10	0	0	0	4000	800	800	400	800	5
Prostate	Viridans-alpha	6	3200	200	100	10	0	0							
Prostate	Viridans-alpha	7	3200	200	100	10	0	10							
Prostate	Viridans-alpha	8	3200	400	100	10	0	0	0	6000	800	800	400	800	8
Prostate	Viridans-alpha[1]	9	2800	200	10	10	0	10	0	4000	800	600	400	800	9
Prostate	Viridans-alpha	10	3200	400	100	10	0	0	0	6000	800	800	400	600	10
Prostate	Viridans-alpha[1]	11	3200	100	100	10	0	0							
Prostate	Viridans-alpha	12	1600	8000	800	800	0	10	2800	0	0	0	200	800	12
Prostate	Viridans-alpha	13	1600	8000	1200	800	0	10	2800	0	0	0	400	800	13
Prostate	Viridans-alpha[1]	14	1200	4000	1200	800	0	10	2400	0	0	0	400	600	14
Prostate	Viridans-alpha	15	1600	8000	800	800	0	10							
Prostate	Viridans-alpha	16	1600	8000	1200	800	0	0	2800	0	0	0	200	800	16
Prostate	Viridans alpha	17	1600	8000	1200	800	0	10							
Prostate	Viridans-alpha	18	1200	8000	1200	800	0	10							
Prostate	Viridans-alpha[1]	19	1600	8000	1200	800	0	10							
Prostate	Hemolytic-beta	20	10	10	10	10	400	10	2400	4000	1200	800	0	800	20
Prostate	Hemolytic-beta	21	0	0	0	10	400	0	2800	4000	800	800	0	600	21
Prostate	Hemolytic-beta	22	0	0	0	0	0	800	2800	6000	800	800	400	0	22
Prostate	Hemolytic-beta	23	0	0	0	0	0	800	2800	4000	800	800	400	0	23
Prostate	Viridans-alpha[1]	24	0	0	100	10	0	0	2400	6000	800	600	200	800	24
Prostate	Viridans-alpha	25	0	0	0	10	0	10	2800	4000	800	800	400	800	25
Prostate	Hemolytic-beta	26	10	10	10	10	0	0							
Prostate	Hemolytic-beta	27	10	0	0	10	0	0							
Prostate	Viridans-alpha	28	0	0	0	10	0	0							
Normal urethra	Hemolytic-beta	29	0	0	0	0	0	0	2800	6000	800	800	400	800	29
Normal urethra	Hemolytic-beta	30	0	0	0	10	0	0	2800	4000	800	600	400	800	30
Normal urethra	Viridans-alpha	31	0	0	0	0	0	0	2800	4000	800	800	400	600	31
Normal urethra	Viridans-alpha	32	0	0	0	0	0	0							
Feces	Viridans-alpha	33	2800	400	100	10	0	0	0	4000	800	800	400	800	33
Feces	Hemolytic-beta	34	0	0	0	0	0	0							
Nasopharynx	Hemolytic-beta	35	10	10	10	10	10	10							
Nasopharynx	Hemolytic-beta	36	10	10	10	10	0	100	2800	4000	800	800	400	600	36
Nasopharynx	Hemolytic-beta	37	10	10	10	100	0	10							
Nasopharynx	Viridans-alpha	38	100	10	0	10	0	10							
Sputum	Viridans alpha	39	10	100	0	10	0	0	2800	4000	800	600	400	800	39
Sputum	Viridans-alpha[1]	40	0	0	0	0	0	10							
Sputum	Hemolytic-beta	41	0	0	0	10	0	0							
Empyema	Hemolytic-beta	42	0	0	10	10	0	0							
Tonsil	Hemolytic-beta	43	0	0	0	10	0	10	2800	6000	800	800	400	800	43
Tonsil	Viridans-alpha	44	0	10	0	0	0	0	2400	4000	800	800	400	600	44
Pleural fluid	Hemolytic-beta	45	10	10	0	10	0	10							
Scarlet fever throat	Hemolytic-beta	46	10	10	0	0	0	0	2800	6000	1200	800	400	600	46
Puerperal sepsis	Hemolytic-beta	47	10	10	10	10	10	10							
Mastoid	Hemolytic-beta	48	10	10	10	10	0	10	2800	4000	800	800	400	800	48

chloride. The buffer effect of the phosphate is well known. Ascites fluid was added to the melted agar in the proportion of 1 part of fluid to 3 parts of agar. The ascites fluid was previously heated to 56 C. for one hour. Plates were used because the surface available is several times that of a slant with an equal quantity of medium. Approximately the 12-hour growth on one plate of a stock strain was suspended in 1 c c of sterile distilled water. The resulting heavy suspension was taken up with a capillary pipet and 2 or 3 drops placed on the surface of each 10 plates. The pipet was then sealed at the end in the flame and bent at an angle of 90 degrees 4 or 5 cm. from the end; now the drops could be quickly and uniformly spread with the bent pipet in a similar manner to that used in making blood smears, and without tearing a less solid medium than could be inoculated with wire loops. The plates were incubated 12-18 hours, and suspensions of the growth in normal salt solution made in amounts of 1 c c per plate. The surface growth was scraped off with a bent capillary pipet and the suspension transferred to graduated tubes which were centrifugated for 20 minutes at high speed. A 50% suspension was made of the bacterial sediment and placed in the icebox as a stock emulsion for later agglutination and absorption tests. It was found that such concentrated suspensions in salt solution would keep several weeks in the refrigerator without deterioration so far as agglutination and absorption are concerned.

The streptococci and especially the hemolytic, which tend to clump spontaneously when grown in broth or on ordinary blood agar, lost this property after a few successive transfers of young cultures on ascites phosphate agar.

Agglutination tests were made with equal mixtures of serum dilutions and a 0.5% streptococcus suspension which were incubated at 52-56 C. for 2 hours when preliminary readings were made. The tubes were then reincubated over night and final readings made the next morning. However, there were only few variations in the two readings in a large number of tests.

A serum which agglutinated in a maximum dilution of 1 : 1,200 gave the same titers macroscopically with suspensions of 0.25, 0.5 and 1% of streptococci.

The tabulated agglutination results show that antistreptococcus serum 1 contains major agglutinations for 11 prostatic streptococci and minor agglutinins for 8 of similar origin. Only one strain of those tested from other sources gave a like reaction. This strain was isolated from the feces of a patient with pyelonephritis. Three other antistreptococcus serums—12, 13 and 14—contained specific agglutinins for 8 prostatic streptococci and group agglutinins for 11 other strains. The group agglutinins of serum 1 were present in rather higher dilution than usual but later absorption tests established the specificity. It may be recalled here that Barnes,[1] found group precipitins for streptococcus extracts in relatively high dilutions. Antistreptococcus (hemolytic) serums 20 and 22 each agglutinated its homologous strain and one other. The remaining strains, including 2 hemolytic, 2 viridans, and 1 alpha prime viridans could not be classified with any of the serums. Four streptococcal strains from the normal urethra were not agglutinated, and with the exception of one feces strain, the other 15 strains from sources outside the genito-urinary tract were not agglutinated except in low dilution. There was no cross agglutination between the hemolytic and viridans streptococci except in very low dilutions. Since two thirds of the streptococci or prostatic origin fall into two related groups and as streptococcus viridans is regarded as a heterologous group, the results seem to indicate some degree of specificity in the types which occur in chronic postgonorrheal prostatitis.

Absorption tests were made with selected strains of each group and also with several other strains which did not agglutinate or only in very low dilutions.

It was found that in order to obtain complete absorption in low dilution, it is necessary to use concentrated suspensions, the serums of higher titer requiring proportionately heavier suspensions.

The following method was used: Titration was first made to determine the amount of streptococci necessary to completely exhaust the homologous serum. Varying dilutions of the stock 50% suspensions were made (25, 12.5, 6.25, and 3.125%) in amounts of 0.1 cc each in small precipitin tubes 4-5 mm. in diameter and to these were added 0.1 cc of serum diluted 1:5. The mixtures were incubated for 2 hours at 53-56 C. with occasional agitation. Control serum tubes without bacterial suspension were also incubated. After incubation 0.1 c c of the fluid was withdrawn from each tube and placed in another set of precipitin tubes and an equal amount of 0.5% streptococcus suspension added to each treated serum, the untreated serum, normal serum, and normal salt solution. If the supernatant fluid was not sufficiently clear it was centrifugated; when a large number of strans were being tested about 20 tubes were centrifugated at a time by plugging the tips of the centrifuge tube containers with cotton and placing 4 or 5 small tubes in each container. One and one-fourth times the smallest percentage of streptococcus suspension necessary to remove the agglutinins were used for absorption by heterologous strains in cross absorption tests. Complete absorption could be obtained in 2 hours by this method.

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[1] Jour. Infect. Dis., 1918, 22, p. 230.

No advantage was noted by heating the emulsion to 65 C. before use, because these mixtures were incubated at higher temperature than usually the case.

The results of the absorption tests indicate clearly that the two main groups are distinctly specific even though the antiserum for one of them was rather strong in common agglutinins.

DISCUSSION

There is a great deal of interest at the present time in the immunologic classification of streptococci and the relation of streptococci to various diseases. Havens[2] classified 93% of 292 strains of hemolytic streptococci from various sources into 3 groups by agglutination; Tunnicliff,[3] Bliss,[4] and Gordon[5] have established a definite immunologic group of certain hemolytic streptococci, isolated from scarlet fever. Any definite grouping of nonhemolytic streptococci so far has not been established. Krumweide and Valentine,[6] made agglutination tests with antistreptococcus serums, produced with endocarditis and tonsil strains, and noted cross agglutination with 3 endocarditis strains while several other strains of the same origin were not agglutinated. One prostatic streptococcus, which they included was not agglutinated by any of their serums.

Holman,[7] and Kinsella and Swift[8] believe that streptococcus viridans constitute a heterogeneous group members of which cause disease only in states of lowered resistance from preexisting infection or other causes. Howell[9] states that a classification of streptococcus could not be made from the results of complement-fixation tests. Barnes,[1] however, found the precipitins relatively specific in high dilution. Clawson,[10] concludes that the nonhemolytic group is widely heterogeneous from agglutination and complement-fixation tests. Williams, Unneberg, Goldberg and Hussey[11] state that in a series of influenza cases the "alpha streptococci" which were dominant "consist of multiple strains from the results of carbohydrate reactions and the action on standard blood agar medium." Bumpus and Meisser[12] find that their results from animal experiments indicate that certain green producing streptococci from focal infection of the mouth produce a specific pyelonephritis. However, they do not state whether their strains were all of the same immunologic type. It seems that the streptococci in postgonorrheal prostatitis possess sufficiently specific features to warrant efforts to trace them back to the sources of infection.

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[2] Jour. Infect. Dis., 1919, 25, p. 315

[3] Jour. Am. Med. Assn., 1920, 74, p. 1387.

[4] Bull. Johns Hopkins Hosp., 1920, 31, p. 174.

[5] Brit. Med. Jour., 1921, 1, p. 632.

[6] Jour. Infect. Dis., 1916, 19, p. 760.

[7] Jour. Med. Research, 1916, 34, p. 377.

[8] Jour. Exper. Med., 1918, 28, p. 169.

[9] Jour. Infect. Dis., 1919, 25, p. 46.

[10] Jour. Infect. Dis., 1920, 26, p. 93.

[11] Jour. Immunol., 1921, 6, p. 53.

[12] Arch. Int. Med., 1921, 27, p. 326.

SUMMARY

A homogenous emulsion of streptococci can be obtained uniformly from young growths on ascites phosphate agar plates.

The quantitative method of making suspensions of centrifugated packed bacteria is more satisfactory than other methods of computation such as counting or comparison with standard barium sulphate suspensions.

Two thirds of the streptococci isolated from chronic prostatic infections can be classified by agglutination into two related groups. This specificity seems to be limited to the viridans (alpha and alpha prime) types of streptococci.

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Illinois, University of . College of Medecine.
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